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Railway Mechanical Engineer

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Have You Written That Story?

The first story entered in the *Railway Mechanical Engineer's* prize story contest is published in this issue. Before the closing date of the competition we hope to receive many more articles. No doubt practically all of our readers have very definite ideas as to the problems the mechanical department is facing. While the actual conditions often cannot be set forth—for various reasons—this story contest gives an opportunity for bringing out the problems and pointing the way to their solution.

Read the story in this issue and then write up some of your own experiences. If the story is published it will be paid for at our regular space rates. In addition the authors of the three best stories will receive prizes of $75, $50 and $25. The use of good English and the literary finish will of course be considered in awarding the prizes, but far more importance will be attached to the ideas brought out, the portrayal of the characters, the reproduction of the railroad atmosphere and the development of the plot. You still have more than two months to send in your contribution, but don't put it off until the last minute. Sit down tonight and see whether you can't write a story that will take one of the prizes.

Hands Off the Draft Appliances

The locomotive front end in its present state of development is a crude affair, designed and regulated as it is on a "rule of thumb" basis. There is probably no other part of the locomotive concerning the operation and adjustment of which so many theories are held, the most creditable of which are founded on a very small amount of fact. The general attitude is that one guess is as good as another and every one, from the fireman up, feels perfectly justified in putting into practice his own ideas whenever opportunity permits. Imperfect as they are, however, there must be some arrangement of the draft appliances on each class of locomotive which, with the least amount of back pressure, will produce a free steaming locomotive. The discovery of this arrangement involves no great difficulty, and when once found there is no reason why it should not apply to every locomotive of the same class.

There are probably few railroads in the country today that have adopted or maintain rigid standards of front-end arrangement. This results in a loss of motive power capacity as well as efficiency. These losses are due to improper adjustments of the draft appliances themselves, such as a restricted opening under the deflector plate, the effects of which are overcome by the use of a nozzle opening small enough to force the locomotive to steam, or defects in other parts of the locomotive, failure from which may be prevented by front-end adjustments.

Unfortunately, within comparatively wide limits other defects may be overcome at the nozzle, but the result is a waste of fuel and the loss of capacity due to excessive back pressure from restricted nozzle area, which has been found in tests conducted by the Fuel Conservation Section to be as great as 10 to 20 per cent in the possible ton-mile per hour output of the locomotive. In this connection, air leaks around outside steam pipes were found to cause an increase in fuel consumption as high as 30 per cent. In such cases, when the remedy is applied at the nozzle, the real difficulty is not corrected; it is merely concealed and permitted to grow as a potential cause of complete failure.

When a standard front-end arrangement has once been established unauthorized changes should not be permitted, and traveling engineers, fuel supervisors and front-end inspectors should all be charged with the duty of reporting immediately any variations from standard which they may discover. When an engine is reported not steaming the real

cause of the difficulty should be located at once and the correct remedy applied. The presumption should always be that the draft appliances never are the cause unless they are found to vary from the standard.

There is no longer any real necessity for providing for adjustments in the front end. If variations from the established standard are to be prohibited the obvious course is to remove as far as possible all temptation to tinker with the draft appliances and the parts should be put in place permanently. This at least will remove the opportunity to change the deflector plates and draft pipes, leaving the nozzle alone, to be taken care of by the adoption and vigorous execution of a policy of "Hands Off."

Testing Refrigerator Cars

There have been notable improvements in the design of refrigerator cars during the past few years and the transportation of perishable products is now receiving more general attention than at any time in the past. For that reason the report of comparative tests of refrigerator cars with two different arrangements of ice receptacles, published in this issue, is of particular interest. In the tests the car equipped with the overhead bunker showed a marked saving in ice consumption and also a lower temperature range throughout the load than the car with end bunkers. It is difficult to determine how much of this saving can be attributed to the overhead ice bunker and how much is due to other differences in the construction of the cars. The insulation in both cases was practically the same, but the Chicago Great Western car was equipped with floor racks, while the Santa Fe car did not have them. There can be no doubt that the free circulation of air resulting from the use of floor racks was largely responsible for the more uniform temperature existing in the Chicago Great Western car, although the location of the ice near the top of the car should prove advantageous in promoting the circulation, particularly when the supply of ice becomes low. Whether a part of the saving in ice is also due to the use of the floor racks can hardly be determined. The data presented in the report is interesting and in view of the decided difference in the results obtained, it is to be hoped that additional comparative tests of end bunkers and overhead bunkers will be conducted with cars which are otherwise identical in construction.

Accidents Due to Washout Plugs

One of the significant facts brought out in the report of the chief inspector of locomotive boilers, an abstract of which appeared in the December issue, is the large increase in the number of accidents caused by arch tube and washout plugs. As compared with the fiscal year 1918, the number has more than doubled, and it is almost 50 per cent greater than the largest number reported during any previous year. The history of this cause of accidents is interesting. Beginning with 1912, when the number of accidents due to plugs was 13, the next two years showed an increase to 20 and 21, respectively, followed by a reduction in 1915 to 16, with practically no change in 1916, and a further material decrease to 8 in 1917. In 1918 there were 14 accidents reported, and during the past year the number was 30.

What conclusions may be drawn from these facts? Probably the only definite conclusion justified by the facts presented is that war conditions have been responsible for the increases in 1918 and 1919—probably by increasing the amount of untrained and inferior labor used for washing out boilers. But that alone is strong evidence of the small margin of safety existing under the best of conditions in the use of these plugs. They must, of necessity, be fitted with threads disproportionately fine by comparison with their diameter, making it always a delicate operation to start the plug in the sheet without crossing the threads. When cross threaded the plugs usually leak. Under such conditions, considerations of safety are largely overbalanced by the pressing necessity for keeping the locomotive in service, and almost invariably an attempt is made to tighten the plug to stop the leak. The only other alternative is to take the engine out of service and cool it down in order that the plug may be removed and properly applied.

It seems evident that there is but one adequate remedy for this class of accidents; that is the elimination of the screwed plug and the substitution of some form of handhold plate to close the arch tube and washout openings in the boiler sheets. The number of accidents due to the failure of these plugs does not place them among the most serious sources of casualties, considering as a whole the years during which the boiler inspection law has been in operation, but the erratic nature of the results from year to year, together with the heavy increase in accidents from this source during the past year are sufficient evidence of the inherent danger involved in the use of the screw plug. The removal of this danger is a matter for the attention of the designer. Let him accept the responsibility.

The Next Step

The communication on how to increase production, which appears on another page, indicates clearly the necessity of improving the morale throughout all departments of the railroad service. The railroads, like the greater number of industrial concerns, have made a serious mistake in the past in not taking more positive steps to acquaint their employees as to the problems, large or small, with which they have been confronted and as to the actual financial condition of the properties.

Railroad employees have consistently demanded better working conditions and higher wages. It is rather strange to find, however, that the labor unions have consistently fought increases of rates and have advocated some very peculiar legislation which would prove most detrimental to the railroads from a financial standpoint and would not give any real advantages to the men. The shippers and the public itself have not gone to any greater extremes in accusing the railroad executives of mismanagement. Investigation of most of these accusations has shown that the wrongdoings, if there were any, occurred many years ago and have been entirely wiped out by improvements to the property which have since been made from earnings; moreover, the conditions under which the roads have operated for a number of years have made anything of this sort impossible. It would seem, therefore, that because of the mutual interests of the men and the managements the men would be glad to co-operate with the railroads in pleading their case before the public.

Is it not true that the managements should adopt far more positive and aggressive methods than they have in the past to acquaint their employees fully with the exact conditions of the properties, financially and otherwise? There is no one way of accomplishing this. If real results are to be obtained all of the officers and foremen, and particularly those who come in direct contact with the men, must unite in conducting a campaign of publicity and education that will place the real facts before the men. This important responsibility up to this time has apparently been overlooked on most roads because those in charge did not realize its importance. Immediate steps should be taken to improve the situation and thereby bring up the entire morale of the service.

The spirit of the letter above referred to should be kept constantly in mind. Improved facilities, better tools and more efficient equipment are all well as far as they go, but the most vital factor in securing greater efficiency or increased production is to improve the morale of the forces.

Why a Fuel Department?

Fuel cost the railroads of the United States approximately $290,000,000 for the year ending June 30, 1914; for the year just closed the expenditure for this item was in excess of $600,000,000. With the fuel bill more than doubled, the number of passenger car miles was practically the same for the two years and the increase in revenue ton miles was not in excess of 40 per cent. Furthermore, the number of revenue tons per train increased from 460 in 1914 to nearly 700 in 1919, a factor exerting a tremendous influence in favor of reduced unit coal consumption. The growing importance of the fuel bill is evident and no railroad can afford not to take effective measures to prevent waste in this expenditure. No doubt, this is generally recognized but the requirements for preventing it are far less generally recognized.

The maximum return from the money spent in the purchase of fuel can only be obtained where there is definite responsibility in some department for the selection, acceptance, storage, distribution and consumption of fuel. A review of the history of the progress of fuel from the mine to the firebox shows that to none of the established departments is the conservation of fuel of more than secondary importance. The selection and purchase of fuel is under the jurisdiction of the purchasing agent, whose interest and responsibility is primarily in securing the best possible price per ton. Whether the quality of the fuel receives adequate attention depends largely on his personality. The storage and distribution of the fuel may be left in the hands of the stores department, the operating department or the mechanical department. Its final use in the firebox is in the hands of the enginemen and firemen with such supervision as the road foreman can give to this matter along with his numerous other duties and assignments. If the fuel is distributed through the purchasing and stores department, the responsibility of these departments ends with the receipt of coal tickets in sufficient amount to effect an approximate bookkeeping balance. With the distribution in the hands of either the operating or mechanical departments, there is much the same opportunity for a shift of responsibility between the coal chute and the firebox because economy in the final use of the fuel is a matter for which neither department alone is responsible.

The main object of the operating department is to get trains over the road, maintaining passenger schedules and keeping the line clear of tonnage and, with the condition of power in the hands of the mechanical department, consideration of economy does not usually go beyond the questions of overtime for crews in appraising the success of this effort. The success of the mechanical department is likely to be measured on the basis of the number of engine failures, little attention being given primarily to obtaining from the locomotives their highest overall efficiency. The road foreman of engines is responsible for the operation of the locomotives; he is also responsible for many matters pertaining to the operating rules and not infrequently is burdened with office duties which leave him little time for the consideration of the locomotive beyond cases of actual failure. None of these departments is responsible for fuel conservation and none is aware of the constant waste which may be taking place daily through the divided and easily shifted responsibility.

The only solution of this problem is the centralization of fuel control in a staff department, the primary purpose of which is to find the leaks and initiate proper practices to stop them.

Much has been done by the Fuel Conservation Section of the Railroad Administration in demonstrating the correctness of the principle of organized fuel control. As compared with 1918, during the past year, on the basis of unit consumption, a saving approaching $40,000,000 has been effected by measures almost entirely within the control of the managements of the railroads of the United States. This is partially the result of the organization of fuel departments on a number of roads not previously having them and partly due to the efforts inspired by the Fuel Conservation Section.

The results from the latter cause are only temporary. If the work of the Fuel Conservation Section is allowed to lapse with the return of the railroads to private operation, there will be a reaction from the inspired effort put forth during the war. Interest in the matter will be lost and wasteful practices in the handling and use of fuel so common before the war, will re-establish themselves. Inspiration is of value only so long as it lasts; continued results can be obtained only where definite responsibility exists.

It seems evident, therefore, that failure to continue the work of the Fuel Conservation Section beyond the term of federal control will result inevitably in the loss of much of the ground which has been gained in the general establishment of correct practices in the handling and use of fuel. The centralized control of fuel conservation measures should be continued through the reactionary period, during which time the summary of locomotive fuel performance compiled and published quarterly by the section should prove of inestimable value in keeping up the interest in fuel conservation measures, as well as in providing concrete evidence of the large return which each road may obtain by the permanent establishment of its own fuel department.

NEW BOOKS

Proceedings of the International Railway General Foremen's Association. 162 pages, 6 in. by 9 in., illustrated, bound in leather. Published by the association, William Hall, secretary, Winona, Minn.

This book contains the proceedings of the International Railway General Foremen's Association convention, held September 2-5, 1919, in the Hotel Sherman, at Chicago, Ill. The addresses delivered before the convention by R. H. Aishton, regional director of the Northwestern region, and L. A. North, president of the association, are given in full. The various papers read before the convention and the discussions of the subjects by the members are recorded and should prove to be a very valuable reference for the members at large. Among the papers read and discussed were several touching on the subject of safety first, by L. A. North, B. F. Harris and W. T. Gale. Other subjects considered were welding of locomotive cylinders, autogenous welding of locomotive parts and several papers on the design and maintenance of draft gear.

Proceedings of the American Railroad Association, Section III—Mechanical. 668 pages, 6 in. by 9 in., illustrated, bound in cloth. Published by the association, 75 Church street, New York.

This volume contains the proceedings of the American Railroad Association, Section III—Mechanical, and covers all of the matters formerly treated separately in the proceedings of the Master Car Builders' Association and the American Railway Master Mechanics' Association. Complete reports are given of the various addresses delivered at the convention by men prominent in railroad affairs, and also the reports of the numerous committees and the discussions by the members. Of particular interest are the papers relating to fuel economy, mechanical stokers, powdered fuel and welding in its various phases, as applied to both the car and locomotive fields. The book was compiled and published by the secretary of the association, V. R. Hawthorne, and covers in the usual complete manner the proceedings of the organization. As in 1918, the standard drawings are issued separately in loose-leaf form.

COMMUNICATIONS

A CORRECTION

Allston, Mass.

To the Editor:

I wish to call attention to an error in the letter "Inadequate Main Driving Boxes," published in the November issue on page 630. The second line in the second paragraph should read: "that where they do hold the box as regards wedge adjustment." It was not my intention to find fault with spring adjusted wedges from the point of view that they do not do the work they were constructed to do in that respect. From my observation they do hold the wedge in adjustment.

John C. Murdock.

DANGERS IN EMPTYING BARREL

La Crosse, Wisconsin.

To the Editor:

In reading the October issue of the *Railway Mechanical Engineer* I noticed the device on page 600 for removing liquids from barrels or other containers. I had one of these connections made about six years ago and have discontinued using it because it proved to be unsafe. A helper was emptying a tank of crude oil and the pressure became excessive and blew the head out of the barrel. This might have caused a very serious accident had the helper been standing in front of the barrel, for the entire head was blown about 40 feet.

I think this may be remedied by using some kind of a safety valve connection, but otherwise the oil is liable to get stopped up and raise the pressure of the tank. I had a ¾ in. pipe for the oil outlet and ¼ in. pipe for the air. All connections were identical with those shown in your sketch.

E. Wagner.

HOW TO INCREASE PRODUCTION

South Orange, N. J.

To the Editor:

Because I have always taken a keen interest in studying human nature, I firmly believe that many of the problems that confront us today could be solved if men in all walks of life would study the characters of the men who are associated with them, not only those in authority over them, but those who work under them. Apply this to the questions asked in the November issue of the *Railway Mechanical Engineer*, "What might be done to improve supervision, to put production on a better basis or take the kinks out of the organization?"

There has been such an upheaval in the management of the railroads during the past two years—old methods discarded and new methods adopted; customs (that had been in vogue so long they were considered essential to the well-being and maintenance of the road) swept aside and a complete reversal of the order of the day—that it would be a waste of time to attempt to draw comparisons between the former and the present methods, in an effort to prove which is the most effective.

Something can be done that will improve supervision, increase production, take out the so-called kinks and put every railroad in this country on a strong, healthy financial basis. It may not be accomplished in a month or a year, because confidence has been almost destroyed, because loyalty is almost a forgotten quantity, because incentive no longer exists, because not only the present methods used, but in a measure the former as well, lose sight of, or rather fail to take into account the one big factor that more than any other affects the growth and success of all organizations, namely, morale.

Every official, every man in a supervisory capacity, every employee must be made to feel that the success or failure of the road is largely dependent on his own individual effort. Create this spirit and you will restore confidence, beget loyalty and incentive, will again inspire new life.

No matter what station in life is yours, if you want success you must be absolutely just in your treatment of those associated with you. Be a big man, play the game fair, be big enough to lay aside petty jealous feelings and selfish motives; when matters arise that affect the interest of others, take them into your confidence and your councils. Bend every energy to produce and promote and the wheels of progress that seem almost to have stopped will revolve again.

Let's start.

H. L. Jackson.

THE COLLEGE MAN IN RAILROAD WORK

Urbana, Illinois.

To the Editor:

From time to time you have published for the benefit of your readers discussions as to the work of the college man in a railway shop organization. Opinions have differed as to just what consideration, if any, should be made for the four years' training he has received in college, but no one heretofore has attempted to bar him from the shop entirely or to claim that the railroads would be better off without any college men whatever.

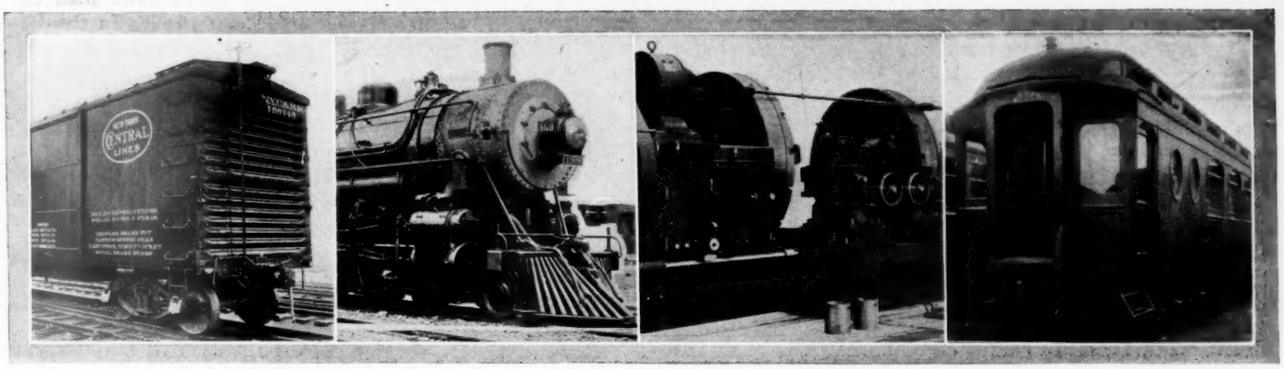
But many of us are wondering how a college graduate is going to get into a railway shop or to acquire the practical experience necessary for him to be able to use this training, provided the terms of the present shop agreement remain in effect.

As a helper, the only position the majority may enter, he can receive no training or experience. His services in an official capacity would be of no value without practical experience. By the time he completes his college course he is generally too old for a regular apprenticeship and generally in debt financially. If one of the few to complete college before passing the maximum age at which regular apprentices may be employed, even if financially able, and possessing sufficient determination to go through the regular grind for another full four-year course, he must serve the greater part of this at a rate of pay less than is paid common laborers.

Upon finishing the full apprenticeship course, and having thus spent eight years in preparation for his life work, he would then, according to the present national shop agreement, be entitled to only the poorest and least desirable job in the shop. He would have less seniority rights than the most ignorant or least ambitious boomer who might have entered the shop the day before the college man completed his apprenticeship, the eighth year of his training. Though the latter might not know an indicator card from a dress pattern, or have no conception of the use to which the job assigned him is to be put, no knowledge of the reason for its design or construction, or of the importance of its being finished accurately or with dispatch, he would have preference in the selection of any job in the shop over this man whose four years of college training had been supplemented by an equal period of practical experience in the very shop where he had already worked practically four years before the boomer happened to light. Would anyone call this a square deal? Or does it offer sufficient inducement to the young man desiring to fit himself for railroad work to enter college to better prepare himself for such work?

We do not know whether the situation in which the college man is thus placed was brought about intentionally or otherwise. But if education means anything at all, if there is any place whatever for the college man in a railway shop organization, some provision must be made to give him the opportunity denied him under the present national shop agreement.

"The College Man."



RAILROADS' MECHANICAL FACILITIES INADEQUATE

Growing Traffic Cannot Be Handled Without Additional Equipment, Estimate of Needs for Next Three Years

SIX billion dollars is the amount that should be spent in the next three years to provide facilities which the railroads will require to handle properly the growing traffic of this country, according to the estimate of the Railway Age. Of this amount nearly $2,000,000,000 should be spent for freight cars, $600,000,000 for passenger cars, $900,000,000 for locomotives, and $150,000,000 for shop and enginehouse equipment.

OTHER FACILITIES

In addition to the rolling stock and shop equipment needed, the Railway Age estimates that the roads should acquire within the next three years 6,000 miles of new tracks at a cost of $600,000,000; revisions of grades, cut-offs and the elimination of curvature, costing $600,000,000; 15,000 miles of new multiple main tracks at a cost of $1,250,000,000; new station buildings costing $300,000, and 10,850 miles of automatic block signals costing $52,000,000.

FREIGHT CARS

There has been serious shortage of freight cars since 1916, except for a few months after the signing of the armistice. The traffic during the last four years has been very heavy, but at present is not greatly in excess of what might be expected under ordinary conditions. The normal traffic for the next six years has been estimated as follows:

	Ton-miles
1920	378,075,000,000
1921	393,815,000,000
1922	410,125,000,000
1923	427,030,000,000
1924	444,540,000,000
1925	462,700,000,000
1926	481,515,000,000

It is probable, however, that the traffic will remain abnormally high for some time to come, and it is estimated that the actual traffic in 1920 will be 410,000,000,000 ton-miles; in 1921, 418,000,000,000 ton-miles, and in 1912, 427,000,000,000 ton-miles.

In order to determine how many cars would be required to move this traffic, a study of the number of ton-miles carried per year for each ton of car capacity was made. This showed that the ton-miles per ton of capacity per year has been in excess of 3,500 for the yearly period whenever there has been a car shortage, and has been below 3,500 whenever was an ample supply of cars. This indicates that one ton of freight car capacity should be provided for every 3,500 tons to be moved during the year. This was actually the case from 1905 to 1915, but the number of cars built in recent years has been abnormally small, and since 1914 there has not been a single year when the railroads have bought enough new cars to take care of the normal increase in traffic.

The Class I roads in 1918 had 2,323,324 freight cars, with an aggregate capacity of approximately 97,000,000 tons. The increase in capacity during 1919 has probably not been more than 1,500,000 tons, making the present capacity 98,500,000 tons. As Class II and Class III roads own about 2.7 per cent of all railroad freight cars, this capacity must be increased by that amount to make it comparable with the statistics of traffic. This would bring the total capacity for all roads to 101,100,000 tons. Under normal conditions this capacity would be sufficient to handle an annual traffic of 354,000,000,000 ton-miles, but since the traffic in 1919 will amount to about 400,000,000,000 ton-miles it is evident that there is not enough equipment to handle it in a satisfactory manner. On the basis of 3,500 ton-miles per ton of capacity per year, the present traffic would require a car capacity of 114,200,000 tons, or about 13,100,000 tons more than is now available. As the average capacity of cars now built is 50 tons, this would indicate that 262,000 additional cars must be provided to make up for the present shortage.

Assuming that business will increase at a constant rate and will reach the normal in 1924, the annual increase will amount to 8,108,000,000 ton-miles, which would require a capacity of 2,320,000 tons. Assuming that the average capacity of the cars built will increase to 55 tons, this would require 42,000 cars. This is not representative of the number that would ordinarily be needed to care for the increase in the traffic, because the present traffic is high, and therefore the assumed rate of increase for the next three years has been made correspondingly low. Under normal conditions about 100,000 cars would be needed to provide for the increase in traffic.

Aside from the question of providing for the traffic, there remains the need for retiring old equipment from service. As the demand for freight cars has been greater than the supply for more than three years, cars have been kept in service whenever it was possible and the number retired has been very low. Statistics indicate that the retirement of 120,000 cars which would naturally have been scrapped during the past three years has been deferred. The Railroad Administration has stated that of the 150,133 cars bad order on the fifteenth of November 19,300 were held out of service as not worth repairing. This is certainly a minimum figure. The deferred retirements amount to at least 100,000 cars, and although some of the box cars may be worth reinforcing

and returning to service, not less than 75,000 cars should be scrapped.

The report of the Interstate Commerce Commission for December 31, 1917, showed that at that time the Class I carriers still had in service 904,007 freight cars not of all-steel or steel underframe construction. Until these light wooden cars have been scrapped the rate of retirement should certainly not be less than 120,000 cars per year. Assuming that 25 per cent of this equipment can be reinforced, there still remain 90,000 old cars to be destroyed during each of the next three years. The average capacity of the cars scrapped will be approximately 33 tons and the capacity of new cars 50 tons. Therefore, to replace the equipment ton for ton would require:

	Cars
For deferred retirements	49,500
For normal retirements.....per year	58,300

SUMMARY

Summing up the cars needed to make up deficiencies, to provide for future increases and to take care of retirements, the total amount of equipment required during the next three years is found to be as follows:

	Cars
To make up the present shortage	262,000
To provide an adequate surplus	100,000
To take care of increases in traffic	126,000
To make up for deferred retirement	49,500
To care for normal retirements	174,900
Total cars needed in three years	712,400
Annual requirements	237,500

The private car lines own about 200,000 freight cars and the Canadian roads have also about 200,000. If the new equipment needed by these car owners bears the same relation to the total number owned that prevails for the railroads in the United States, the car-building plants of this country and Canada should be called upon to furnish 830,000 cars during the next three years.

TYPE OF CARS THAT WILL BE BUILT

Few important innovations in freight car design have been introduced in the past decade, and the equipment built during the next few years will probably not be radically different from the types now in service. Box cars form a large percentage of the equipment and little further increase in capacity is to be expected, as the opinion seems to prevail that nothing is gained by increasing the capacity of box cars above 40 tons. In open-top equipment, however, there is a strong tendency toward the use of high-capacity units. Ninety-ton cars are by no means uncommon, and experimental cars of 105 and 110 tons' capacity have been constructed. The operating results secured with high-capacity cars have been satisfactory, and they will probably be built in greater numbers.

The unit cost of the equipment which the railroads buy in 1920 will be greatly in excess of pre-war prices. The lowest scale of prices for freight cars in recent years was that prevailing in 1914 and 1915. At that time cars could be bought for $800 to $900. By 1916 they had advanced to $1,100, in 1917 to $2,100 and in 1918 the average was about $2,850. The prices that will prevail during 1920 will depend on the cost of materials, and cannot be predicted with any degree of certainty. Under present conditions practically the same prices that existed in 1918 apply. It is probable that the 240,000 cars that should be built this year would cost between $670,000,000 and $700,000,000. Assuming that present prices continue the 712,000 cars needed in the next three years will involve an expenditure of approximately $2,000,000,000.

PASSENGER CARS

The shortage of passenger equipment at the present time is brought out strikingly by the fact that in 1919 the number of passengers per car was 31 per cent greater than the maximum during any year from 1905 to 1915. In the 10-year period ending June 30, 1915, the volume of passenger traffic on the railroads of the United States, as measured by the number of passengers carried one mile, increased 48 per cent. During this period 26,800 passenger train cars were purchased.

In the four and one-half years since June 30, 1915, the number of passengers carried one mile has increased over 43 per cent, but less than 4,000 cars have been purchased. To provide for the present volume of passenger traffic on pre-war standards of service, without allowance for retirements, would require over 18,000 more passenger train cars than the railroads now own.

During the ten calendar years ending with 1914, the Railway Age reports a total number of passenger cars ordered of approximately 22,900, of which 78 per cent were for the steam railroads of the United States. During the same period Railway Age statistics show a total of approximately 34,400 passenger cars actually built in the United States and Canada. While it is evident that the statistics for the number of cars ordered is not as complete as for the number of cars built, it is reasonable to assume that approximately the same proportion in each case were for use on the steam railroads of the United States. On this basis it is evident that the railroads must have received about 26,870 new passenger train cars during the ten years from 1905 to 1915. But during this time the actual number of cars in service increased only 14,063, and it is evident that about 12,800 cars must have been retired. The yearly average for the ten years is, therefore, 2,687 new cars purchased, of which 1,280 replaced old cars retired from service and 1,406 were added to take care of the traffic increase.

During the four and one-half years since June 30, 1915, passenger miles have increased 13,810,000,000, or 43.5 per cent. This is a larger proportionate increase than that for the ten years prior to 1915 and but slightly less than the actual maximum increase during the period from 1905 to 1914.

During the first year and one-half of this period there was actually less passenger equipment in service than at the beginning of the period, and at the end of 1917 there were only about 300 more passenger cars in service than were shown for the fiscal year 1915. For the whole period of four and one-half years, with its increase in volume of passenger business of over 43 per cent, the number of passenger cars in service increased by 2.5 per cent.

While the number of cars ordered during the four calendar years ending with 1918 was approximately 7,000, only 45 per cent of this number were for use on the steam railroads of the United States. Applying the same percentage to the approximately 7,490 cars built during the four and one-half years prior to December 31, 1919, only 3,370 passenger train cars were built for steam railroad use in the United States. As at least half of the cars built in 1915, or about 440, were probably in service prior to July 1, the beginning of the period under discussion, the number of new cars actually placed in service in the four and one-half years probably did not exceed 2,930. As the number of passenger cars in service increased but 1,310 during the period, it is evident that about 1,620 cars were retired. An average of only 652 new cars were received by the roads annually, of which 360 were replacements and 291 were additions to the passenger carrying equipment of the country.

Comparing the years up to 1918, there is evident a growing inability of the equipment available to meet the heavy increase in traffic, which is shown by the increase in the number of miles per passenger carrying car per year from 59,600 in 1915 to 66,000 in 1917, with a corresponding in-

crease in the number of passengers per car from 15.3 in 1915 to 17.6 in 1917.

In 1918 there was a sharp decrease in car mileage, due to the curtailment of service effected by the Railroad Administration. This and an increase in the number of cars in service of 961 resulted in lowering the average car miles per passenger carrying car from 66,000 to 58,600, but the number of passengers per car increased from 17.6 to 20.4, by far the largest increase ever recorded. Of course, the heavy troop movement, which was practically continuous throughout the year 1918, tended to increase this figure above that representing conditions prevailing in the handling of regular passenger business. The aggregate of this troop movement for the 22 months from January 1, 1918, to November 1, 1919, however, was 5,917,658,719 passenger miles, or only 14 per cent of the total volume of passenger business of the year 1918 alone, and can hardly have exercised a predominating influence on the average. Its effect may practically be eliminated by comparing 1917 with 1919, as the troop movement during these two years was confined to about one-half of the year in each case, and here the increase is shown to have been over three passengers per car.

The sharp decline in passenger car mileage, showing an average of 58,600 and 61,400 miles per car per year, respectively, for 1918 and 1919 following the high mileage during 1917, raises the question as to whether the change in conditions is actually due to a shortage of equipment or entirely to the war policy of the Railroad Administration. Assuming, however, that the equipment had been used to the same extent during these two years as it was during 1917, so that each passenger carrying car had averaged 66,000 miles for the year, the number of passengers per car would have increased to 18.1 in 1918 and 19.3 in 1919, clearly demonstrating that even under normal methods of handling passenger business there would still have been a rapidly growing shortage of equipment.

Passenger equipment may be divided roughly into two major classes: (1) passenger carrying cars and (2) express, baggage and postal cars. In the tables already referred to are given a clear presentation of the volume of passenger traffic and the total number of passenger carrying car miles to handle the traffic. This forms a fair basis for determining the needs for passenger carrying cars if the assumption is made that there has been no great change in the relative amount of car mileage made by equipment of railroad ownership and Pullman sleeping and parlor cars, or that there has been no material increase in the carrying capacity of passenger cars of railroad ownership. The remarkable uniformity of the number of passengers per car during the eight years prior to June 30, 1915, would indicate that these are reasonable assumptions. At the end of that period there were 10,884 passenger train cars of all-steel construction and 5,197 with steel underframes, a total in both groups of 38 per cent of the equipment in service, practically all of which had been built during that period, with no marked effect on the average car load.

Leaving out of consideration the first three years of the ten years prior to 1915, during the first two of which the number of passenger-miles per passenger carrying car was light, and considering only those years for which passenger car mileage statistics are available, it will be found that the average number of passenger-miles per passenger carrying car average about 950,000, which was equivalent to an average of about 61,500 miles per car per year with an average load of 15.4 passengers per car. To have handled the 45,060,000,000 passenger miles of passenger traffic in 1919 under these same conditions would have required a total of 48,000 passenger carrying cars, but there were only approximately 35,700 passenger carrying cars in service during that year, indicating a shortage of 12,300 cars.

But it is questionable whether passenger service should ever be restored completely to the competitive basis existing prior to 1915. It will be conservative to assume that the service should be restored to the standards of 1917, when there were 17.6 passengers carried per car movement, and it would seem reasonable to expect the maintenance of an average mileage per car throughout the country of 63,000 per year. To have handled the 45,600,000,000 passengers carried one mile in 1919 on this basis would have required 41,080 cars, which is 5,480 cars more than were actually in service.

Assuming for the next three years an annual increase of an even 2,000,000,000 passenger-miles, the railroads will be required to purchase 5,400 additional passenger carrying cars during the three-year period to maintain the standards of service and equipment mileage outlined above. It will, therefore, be necessary to purchase 10,880 passenger carrying cars during the next three years.

During 1918 the passenger carrying cars of the Class I railroads made up 66 per cent of the total number of passenger train cars in service. Assuming the continuance of this ratio, which, however, has been gradually decreasing, it will be necessary to purchase 5,620 new baggage, mail, express, dining and other passenger train cars in addition to the passenger carrying cars, which include coaches, combination passenger cars and sleeping and parlor cars of railroad ownership. Of this number about 4,800 will be baggage, mail and express cars.

During the ten years prior to 1915 there was an average retirement of 1,280 cars annually. During the last four years there has only been retired an average of 360 cars each year. It is evident, therefore, that there are 4,140 cars now in service which should be retired at the earliest opportunity, and on the same basis 3,840 more cars should be retired during the next three years. Adding these 7,980 cars to the actual increase required, it is evident that there must be purchased during the next three years a total of about 24,500 passenger train cars, or an average of 8,160 cars a year, if passenger service is to be restored to the 1917 standards.

Such data as is available indicates that the increase in prices of passenger cars which has taken place during the war period has been about 200 per cent, or in other words, that the equipment purchased now will cost approximately three times as much as the cost of similar equipment purchased in 1914. This ratio holds very closely true when applied to the prices for locomotives and freight cars paid by the Railroad Administration during 1918, and, considering the increases in prices which have taken place since, it may be considered a conservative basis on which to estimate the capital required for the purchase of new equipment. Baggage, mail and express cars costing between $6,000 and $7,000 in 1914 will cost on an average of $21,000 to $22,000 at the present time, while steel coaches which cost $8,500 in 1914 can probably not be built at the present time for less than $25,000 to $26,000. Applying these prices on a weighted average basis of the proportion of these two classes of equipment to the total, a conservative price for the 24,500 cars required in the next three years may be taken at $24,000 each.

If the railroads are to restore and maintain passenger service to the standard of 1917, an expenditure, therefore, of $588,000,000 will be required for new equipment during that time; this is an annual average of $196,000,000.

LOCOMOTIVES.

The motive power situation is fully as serious as the shortage of freight and passenger cars. A conservative estimate, based on the average increase in railroad traffic and in the motive power during the decade ending with the year 1914, indicates that at least 698,000,000 lb. additional tractive power should be built in the next three years.

During the period from 1905 to 1915, in addition to an

increase of 34 per cent in the number of locomotives on American railroads, there also was an increase of 71 per cent in the aggregate tractive power. Statistics of the Interstate Commerce Commission show that the average distribution of tractive power is 63.5 per cent in freight service, 20.5 per cent in passenger service, 14 per cent in switching service and two per cent unclassified. The estimates of future requirements are based on these ratios, and the small percentage of new unclassified locomotives is included with those for freight service.

In the year 1905 the freight traffic of the United States totaled 186,463,109,510 ton-miles, and this increased at a fairly constant rate until in 1914 it had reached a total of 288,319,890,210 ton-miles, an average yearly increase for the decade of 5.46 per cent. This rate of increase if continued to the end of the year 1919 would have made a total freight traffic of 388 billion ton-miles. However, the statistics of the first ten months of the year 1919 and a conservative estimate of the probable volume of business for the months of November and December indicate that the actual freight business for the year will reach the enormous total of 402 billion ton-miles. These figures for the year 1919 may be taken as a basis on which to estimate the probable freight traffic for the next three years, which will probably reach 410 billion ton-miles in 1920, 418 billion ton-miles in 1921 and the stupendous total of 427 billion ton-miles in 1922.

To handle properly this vast amount of freight in 1920 it will be necessary to have an aggregate tractive power of 1,651,000,000 lb. in freight locomotives. This will require the building of a large amount of additional motive power. New freight locomotives to be built should average about 60,000 lb. tractive effort.

The statistics of the Interstate Commerce Commission show that in the past years approximately 63.5 per cent of the total available tractive power was engaged in freight service, and on that basis 248.3 ton-miles of freight were hauled during the year for each pound of tractive power of freight locomotives. The average ton-miles per year per pound of tractive power was somewhat in excess of 248.3 in 1918 and 1919, but an average taken over the entire period of 14 years from 1905 to 1918 was only 251.1 ton-miles per year per pound of tractive power. This average is subject to fluctuation, and as will be seen in the tabulations the average ton-miles per pound of tractive effort in 1906 reached the extremely high figure of 273 ton-miles, but dropped to 235 ton-miles in 1914. It is for this reason that an average for a ten-year period during normal times is taken as a basis for calculating the work that will probably be done in the future. This average may be improved upon, but there is no certainty that such will be the case.

As already stated, the estimated freight traffic for the year 1920 will be 410 billion ton-miles, and to haul it will require freight locomotives having an aggregate tractive power of 1,651,228,000 lb. On the basis given above, 153,245,000 lb. additional tractive effort would be needed to bring the aggregate for 1919 up to the proper point, and to this amount must be added 32,218,000 lb. necessary to provide for the increase in freight traffic in 1920. The increase in freight traffic to 418 billion ton-miles in 1921 will require an increase of 32,219,000 lb. tractive power, and the increase to 427 billion ton-miles in 1922 an additional 36,246,000 lb. Normal and deferred retirements of freight locomotives during the next three years make it necessary to provide 190,472,000 lb., and the proportional increase in unclassified locomotives an additional 8,091,000 lb., so that it will require an aggregate increase of 452,490,000 lb. tractive power in freight locomotives in three years. This makes a total to be built of 7,542 units of 60,000 lb. average tractive effort. As heavy freight locomotives cost approximately $82,000 in 1918, and it is quite probable that this price will continue, the total cost of freight locomotives required in the next three years will be $618,444,000. This is a yearly average of 2,514 freight locomotives, costing $206,444,000.

PASSENGER LOCOMOTIVES

The passenger traffic of the railroads of the United States during the decade ending with the year 1914 increased 11,458,246,073 passenger-miles, or 48 per cent. During this same period the number of passenger locomotives increased only 25.8 per cent, but as in the case of freight locomotives the average tractive power increased rapidly.

The passenger locomotives in service in the year 1914 were 23 per cent of the total number of locomotives and the aggregate tractive effort amounted to 396,051,000 lb., or 20.5 per cent of the total for all classes. No figures being available as to the actual aggregate tractive effort engaged in passenger traffic in recent years, it may reasonably be assumed that the same ratio that existed in 1914 (20.5 per cent) will apply. On that basis the passenger traffic for the year 1919 would have required 521,669,000 lb. tractive power, but the total available power was only 473,199,000 lb.

The total available tractive effort on December 31, 1918, being 2,196,648,349 lb., and assuming that 20.5 per cent of this amount was engaged in passenger traffic, this additional tractive effort required for passenger service to bring the total for the year 1919 up to normal would be 48,470,000 lb., and with the increase computed on the basis of 20.5 per cent, 11,404,000 lb. are required for 1920, 10,401,000 lb. for 1921 and 11,702,000 lb. for 1922. To replace the normal and deferred retirements of obsolete passenger locomotives 59,613,000 lb. are required, making a total increase of 141,601,000 lb. tractive power required to be built for passenger service in the next three years.

This would require a total of 3,218 units of 44,000 lb. tractive power each, and as the probable cost of passenger locomotives will approximate $60,000 each, it will necessitate a total expenditure of $193,080,000 for this purpose during the next three years.

SWITCHING LOCOMOTIVES

The I. C. C. statistics show that 15.6 per cent of the total number of locomotives in service were switching locomotives, and on the basis of 14 per cent of the aggregate tractive power there were 323,160,000 lb. of tractive power in switching service in the year 1919. Additional power of 33,785,000 lb. tractive effort are required to bring the switching service to its proper proportions, and this amount should be constructed in the year 1920. To meet the normal increase in traffic in 1920 will require 7,105,000 lb., the increase in 1921 will require 7,203,000 lb. and in 1922 it will require 7,891,000 lb. additional tractive power.

Besides these increases, the deferred and regular retirements of switching locomotives to be replaced with modern power will require 40,712,000 lb., making necessary a total increase of 96,696,000 lb. tractive effort in the next three years. Taking 40,000 lb. tractive power as an average for this class of locomotives, this would require 2,417 units, and at an average cost of $40,000 each the total cost of switching locomotives to be built in the next three years would be $96,680,000, or a yearly average of 806 locomotives, at a cost of $32,226,666, which represents the requirements of this class of the service.

SUMMARY

The total increase in the aggregate motive power required in the next three years and the estimated cost is as follows:

Normal increase in lb. tractive power:	
Freight locomotives	261,928,000
Unclassified locomotives	8,099,000
Passenger locomotives	81,988,000
Switching locomotives	55,985,000
Total	408,000,000

Deferred and normal retirements in lb. tractive power:	
Freight locomotives	190,472,000
Passenger locomotives	59,613,000
Switching locomotives	40,712,000
Total	290,797,000
Cost of replacing retirements:	
3,175 freight locomotives	$260,350,000
1,332 passenger locomotives	79,920,000
1,017 switching locomotives	40,680,000
Total	$380,950,000
Cost of retirements when built:	
9,320 freight and unclassified locomotives	$142,400,000
2,760 passenger locomotives	41,700,000
1,920 switching locomotives	21,300,000
Total	$205,400,000

	Tractive power, lb.	Number of locomotives	Cost
Normal increase and retirements	407,999,000	7,653	$527,254,000
Deferred retirements	290,797,000	5,524	380,950,000
Total	698,796,000	13,177	$908,204,000
Average per year for three years	232,599,000	4,392	302,735,000

The cost of locomotives to be retired is taken as equal to the cost in the year 1905, when freight locomotives cost $15,250, passenger locomotives $15,100 and switching locomotives $11,100. This will retire from service locomotives costing $205,400,000 when built, and the capital expenditures of the railroads for locomotives will therefore be $702,804,000 in the next three years, as shown below:

Total cost of locomotives to be built in three years	$908,204,000
Total cost of locomotives to be retired in three years	205,400,000
Addition to capital expenditures	$702,804,000

The total number of locomotives that should be built in the next three years is 13,177 and the total to be retired is 12,000 locomotives, making an increase of 1,177.

SHOP AND ENGINEHOUSE EQUIPMENT

In attempting to make an estimate as to the amount that railway repair shops are behind in their shop and enginehouse equipment, it will be necessary to know how much has been spent for this purpose in the past few years.

TABLE I—STATISTICS FOR CLASS I CARRIERS

For fiscal year ending	Total operating expenses	Account 302 shop machinery	Per cent of total expenses
June 30, 1911	$1,844,065,958	$10,061,423	.546
June 30, 1912	1,898,662,465	10,417,543	.548
June 30, 1913	2,108,947,614	12,182,668	.578
June 30, 1914	2,139,755,988	11,674,904	.546
June 30, 1915	2,021,160,614	8,916,891	.441
June 30, 1916	2,210,892,786	10,295,918	.466
December 31, 1916	2,357,398,412	11,517,657	.489
December 31, 1917	2,829,325,123	14,552,997	.514
December 31, 1918	3,948,132,200	27,520,000	.696
December 31, 1919	4,335,000,000*	30,250,000	.698

*Estimate based on statistics for the first ten months of 1919.

Reference to Table I shows that in the fiscal year ending June 30, 1911, $10,661,423 was spent for shop equipment and to repair and replace worn-out shop machinery. There was an increase to $12,182,668 in the following two years, but for the succeeding four years the shop machinery charge was below normal. It was not only small, but a relatively small proportion of the total operating expense. This failure to keep repair shop facilities up to the necessary standard was due, as previously stated, to the difficulty of securing capital, scarcity of labor and the high prices and scarcity of materials. With the beginning of government control in 1918 capital was available, and the priority given to government orders made possible the purchase of railway equipment. Consequently the shop machinery charge practically doubled during the year 1918, as indicated on the chart. This does not mean, however, that twice as much machinery and equipment was repaired and replaced in 1918 as in former years. The fact is that twice as much money was paid for the usual amount of equipment. A canvass of machine tool builders and other manufacturers indicates that 100 per cent is a conservatives estimate of the increase in cost of machine tools and shop supplies since 1916.

The ratio of shop machinery to total operating expense in 1911 was .546 per cent. This ratio increased to .578 per cent in 1913 and then, due to causes before stated, dropped below normal for the succeeding four and a half years. During 1918 and 1919 the ratio increased to .696 and .698 per cent, respectively.

If, however, the ratio is considered constant at .578 per cent during this period, a conservative estimate of the deficiency in shop machinery during this period will be obtained. The difference between .578 and the actual ratio for any one year multiplied by the total operating expense for the corresponding year will give the difference between the amount of money that should have been spent on shop machinery for that year and the amount that was actually spent. These amounts have been calculated, and their sums are

TABLE II—1918 STATISTICS OF SIX REPRESENTATIVE ROADS

Name of road	Total operating expenses	Account 302 shop machinery	Per cent of total expenses
Atchison, Topeka & Santa Fe	$144,912,375	$884,374	.610
Chicago, Burlington & Quincy	112,067,616	997,507	.890
Southern Pacific	113,652,897	738,237	.650
Chicago, Milwaukee & St. Paul	122,196,105	531,558	.434
Pennsylvania (Lines East)	333,624,523	2,886,760	.865
Pennsylvania (Lines West)	86,550,256	632,213	.729
Total	$913,003,772	$6,670,649	4.178
Average per cent			.696

shown in Estimate (a) as $9,835,000. However, the statistics given in Table I apply to Class I roads only. The operating expenses of Class I roads are about 96 per cent of the total operating expenses of all carriers, and 4 per cent has been added to $9,835,000, making a total of $10,229,000. But this equipment and machinery should have been bought previous to 1917, and it will now cost 100 per cent more to replace it, which brings the deficiency up to $20,458,000.

During the years 1918 and 1919 the amount of money spent for shop machinery was greater than the average, but the machinery and equipment actually acquired was probably less than normal, due to the depreciated value of the dollar. The amount of money spent during the same period for additions and betterments to take care of increased business was wholly insufficient. The replacement value of railway shop machinery in the United States is $292,200,000. Inasmuch as the annual increase in equipment has been not less than 3.70 per cent and it will require at least 4.2 per cent increase in shop facilities to handle this equipment, the necessary additions and betterments may be expressed as .042x2x292,200,000=$24,450,000. The total deficiency in shop machinery and equipment up to the present time, therefore, is shown in Estimate (a) as $44,908,000.

Data extending over a four-year period show that only 67 per cent of the shop machinery charge represents material, the balance representing the labor required to repair and replace the worn equipment. Consequently, as shown in Estimate (b), there is $20,250,000 worth of material in the annual shop machinery charge. This must be increased by 4 per cent to include all roads; and in a period of three years the total estimated amount of material to be bought will cost $64,470,000.

That this figure is not excessive may be shown by a consideration of reasonable depreciation charges for the three-year period. It is true that some shop machinery has been used for 20 years or more, but with the continual modern changes and improvements it is doubtful if any machine will have a useful and efficient life greater than 15 years. This means an annual depreciation of 6.67 per cent, which for three years on an investment of $292,200,000 is $58,500,000. In other words, the estimate of $64,470,000 for shop facilities would hardly do more than cover shop machinery depreciation.

Additions and betterments, being chargeable to capital

account, provide the necessary equipment to care for increased business. In order to estimate future needs, it is necessary to examine past expenditures for this account. In the 30 months from June 30, 1914, to December 31, 1916, only $6,063,719 was spent for shop machinery additions and betterments. During the following year $6,000,000, and in the first year of government control $7,698,596 were spent for machine additions and betterments, but that this amount was entirely inadequate for the needs is indicated by the fact that only 35.2 per cent of the authorized additions and betterments were actually made.

According to estimates made in 1916, the total value of railway shop machinery in the United States amounted to $146,100,000. Referring to Estimate (c), the replacement value of this machinery in 1919 would be at least $292,200,000. Assuming then that the plant must be increased 4.2 per cent per annum to care for the new equipment, the total investment in the next three years must be $36,780,000.

The total amount of money that should be spent during the next three years for shop equipment and machinery, as shown in Estimate (d), is $146,158,000. This amount is probably less than the actual needs. The magnitude of the material costs are for machinery, which means that during the next three years $54,100,000 should be spent for railway shop machinery and machine tools.

The summary given above is exclusive of the structures required for shops and terminals. According to the estimate of the Railway Age, $250,000,000 should be spent on these buildings during the next three years.

ESTIMATE

(a)	Deficiency in shop machinery:		
	From June 30, 1913 to December 31, 1917—		
	.578 — .546 = .032 × $2,139,755,988 =	$685,000	
	.578 — .441 = .137 × 2,021,160,614 =	2,770,000	
	.578 — .466 = .112 × 2,210,892,786 =	2,475,000	
	.578 — .489 = .089 × 2,357,398,412 =	2,095,000	
	.578 — .514 = .064 × 2,829,325,123 =	1,810,000	
		$9,835,000	
	Adding four per cent to include all roads..	394,000	
	Deficiency in shop machinery December 31, 1917	$10,229,000	
	Cost of replacing in 1919	$20,458,000	
	Deficiency in additions and betterments to December, 1919	24,450,000	
	Total	$44,908,000	$44,908,000
(b)	Maintenance of shop machinery (for three years 1920-1922):		
	Annual shop machinery charge	$30,250,000	
	But only 67 per cent is material	20,280,000	
	Adding four per cent to include all roads...	1,210,000	
	Total material to be purchased annually	$21,490,000	
	For three years	3	
	Total	$64,470,000	$64,470,000
(c)	Additions and betterments (for three years 1920-1922):		
	Value of shop machinery in 1916	$146,100,000	
	Replacement value in 1920	292,200,000	
	Annual equipment increase of 3.7 per cent will require 4.2 per cent investment in machinery	12,260,000	
	For three years	3	
	Total	$36,780,000	$36,780,000
(d)	Grand total (a) + (b) + (c)		$146,158,000

result gives some indication of how serious the situation has become. The cost of all materials has practically doubled in the past three years, shop employees' hours have been reduced to eight hours and wages have increased on the average at least 100 per cent. To offset these increased costs and place back into service the locomotives now held waiting repairs, it will be necessary to make up previous deficiencies in equipment and modernize all shops.

Automatic and semi-automatic machinery, for example, should be more generally used in back shops where material is manufactured for the whole system. Another field that deserves particular attention is the enginehouse machine shop.

The material and equipment purchased for railway shops and included in this discussion is of almost infinite variety from belts, air hose, rope and packing to boilers, cranes, welding equipment, lathes, etc. The largest single item is machinery and tools. Approximately 38 per cent of the total

THE INCENTIVE FOR HIGHER EFFICIENCY*

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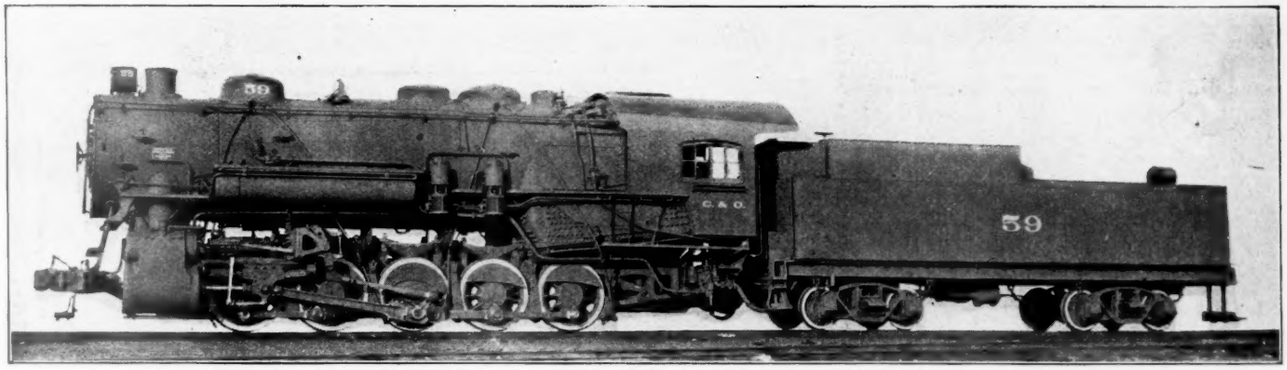
Our ablest statesmen, economists, and financiers, as well as our leading business men are confronted with an industrial problem—perhaps the most serious in the history of our country—the labor unrest which is almost universal. My experience with a small organization of railroad men in France taught me some lessons about this problem. These men in a strange environment, with almost no facilities for efficient work, housed in barracks, eating in the open from their mess kits, performed one of the quickest and most efficient jobs of erection work that I have ever witnessed. The reason for this efficiency was that there was an incentive which caused them to put forth their best efforts to accomplish the task in hand.

Our labor unrest today is largely due to lack of incentive. We do not see the future clearly. You men are in intimate daily contact with a large proportion of the workers employed in the various shop crafts on our American railroads. You must be the leaders in an educational movement that will prove to those with whom you come in contact that there exists today one of the greatest incentives for doing efficient work that has ever appealed to the railroad men of this or any other country. That incentive is nothing less than the re-establishing of permanent prosperity for the American people. We must all become teachers of economics. The lesson to be taught is that high wages and permanent work depend on production. We must give a fair day's work for a fair day's pay. We must bend every effort toward wiping out the thought that the curtailment of production means more jobs and better living conditions.

The present standard of wages can be and will be maintained if they are earned. They cannot be and will not be maintained if production is decreased in proportion as wages are increased. We Americans receive the best wages for the shortest hours of work that are received by any workmen in the world. In order to maintain and improve this standard we must give full value for what we receive. Getting something for nothing is contrary to the laws of nature. Production is the basis of the solution of our present day problems. Profiteering can and will be wiped out by existing law or by new laws formulated to meet the new conditions. Labor itself has the power to resist unfair practices. Capital and labor are partners. They must co-operate. A spirit of loyalty must be obtained not only between the workman and his boss, but between the boss and his workmen.

Those 200 railroad men in France were a host in themselves. They overcame difficulties that were seemingly insurmountable. They did their work cheerfully, willingly and happily. It was a pleasure to them and their production was phenomenal. If the vast group of railroad workers in America today felt that same spirit of co-operation, that same spirit of comradeship, that incentive to accomplish things because of the spirit of loyalty pervading the work, production would increase, the cost of living would decrease, the present standard of wages would be maintained or bettered and there would be a joy in work that would make for continued peace of mind and prosperity.

*From an address at the General Foremen's Convention.

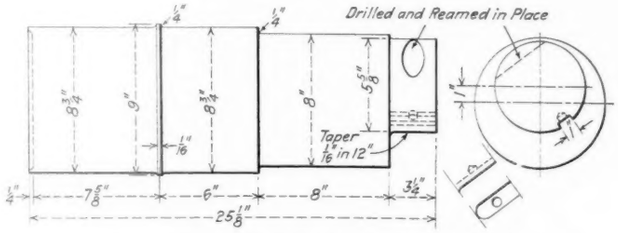


Heavy Ten-Wheel Switcher Built for Chesapeake & Ohio

HEAVY SWITCHERS BUILT FOR THE C. & O.

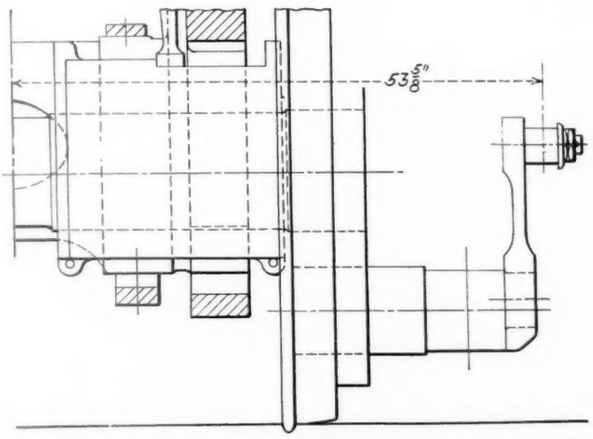
More Power Required to Move Heavy Trains
New Locomotives Have 63,000 lb. Tractive Effort

THE demands made upon switching locomotives by the heavy tonnage trains of the present day have resulted in the building of some very heavy 10-wheel switching locomotives for the Chesapeake & Ohio. The tonnage of many trains has grown to such proportions that they are beyond



Main Crank Pin with Offset Eccentric Boss

the capacity of any locomotives used for switching except the Mallet type locomotives. These 10-wheel switching locomotives are the largest and heaviest non-articulated switchers ever built. The total weight on drivers is 295,000

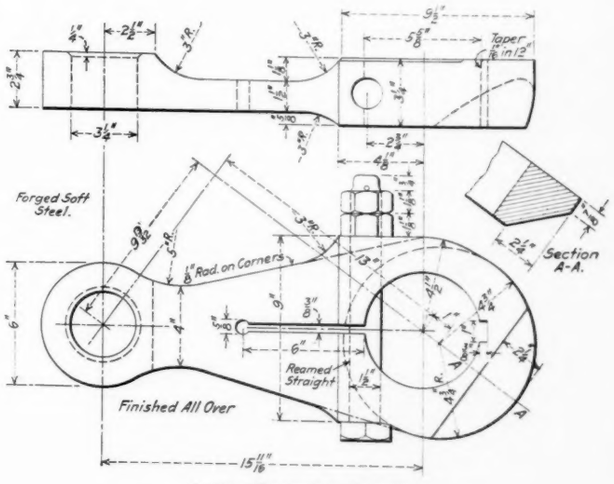


Application of the Eccentric to give Clearance Above the Rail

lb. and the tractive effort is 63,000 lb. They were designed by the mechanical department of the Chesapeake & Ohio with the co-operation of the American Locomotive Company, which built the locomotives at its Richmond works. Some very interesting and difficult problems were encountered in the design of these locomotives, but the results have been very satisfactory.

The driving wheels all have flanged tires 5¾ in. wide and in order to keep the wheel base at a minimum, are made as small in diameter as practicable. With 51-in. diameter driving wheels spaced as closely as posible, the total wheel base is only 19 ft. and these locomotives can pass over curves of 14 deg. without the use of lateral motion driving boxes.

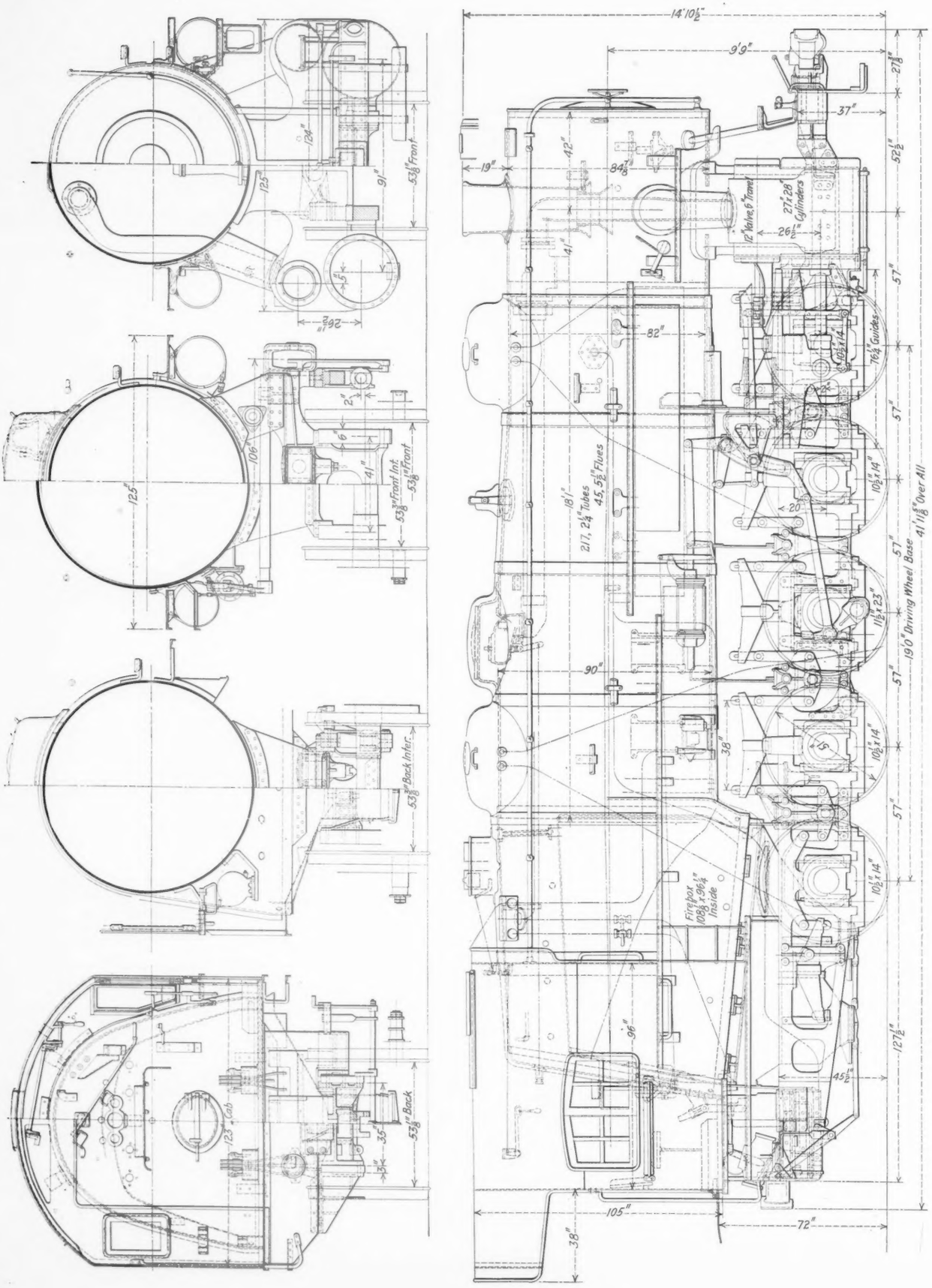
The steam pressure is 185 lb. per sq. in. and the cylinders are 27 in. in diameter with a 28-in. stroke. The small driving wheels with this 28-in. stroke and the large crank



The Eccentric Crank

pins necessary for an engine of this high power made the question of clearance of main rod straps and eccentric cranks a rather difficult problem. The hub of the eccentric crank was kept above the rails the required distance by making the main crank pin boss eccentric, as shown in the drawings.

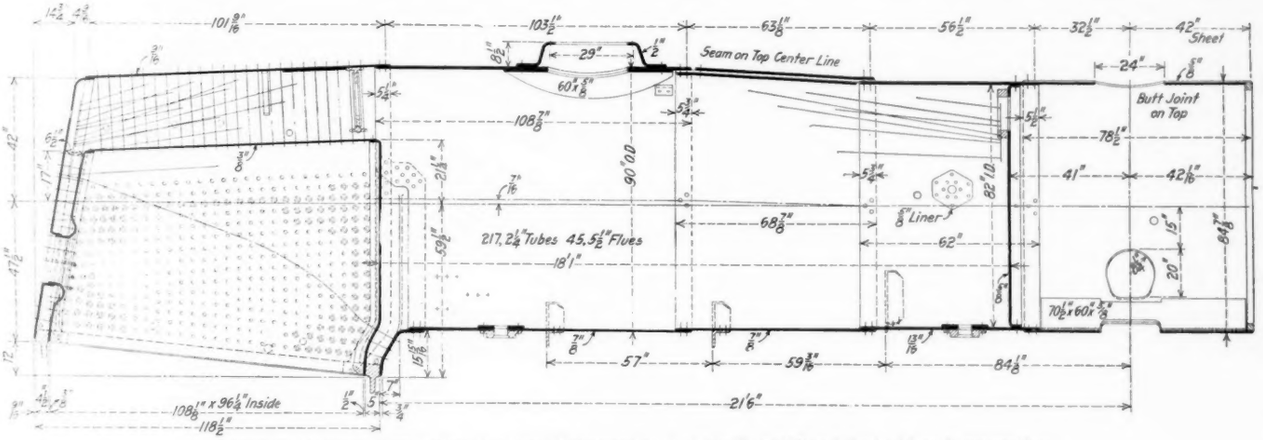
The side rods are of a design differing from the usual arrangement. Instead of the usual rear knuckle joint connection the fourth crank pin is made with two journals, and the back crank pin is extended in a manner similar to the style used on many American type eight-wheel locomotives. The back section rod is independent of the forward side rods and



Elevations and Sections of the Ten-Wheel Switcher Built by the American Locomotive Company for the Chesapeake & Ohio

is on the outside, in line with the main rod. The guides and crosshead shoe being solid bronze with very liberal bearing surfaces, designed to give long wear.

The total length of this locomotive from the front bumper to the tender end sill is 75 ft. 9¼ in., the overall height is 14 ft. 11¾ in. and the width over running boards 10 ft. 5 in. The locomotive frames are 6 in. wide and have ample depth over the pedestals to provide the required strength to



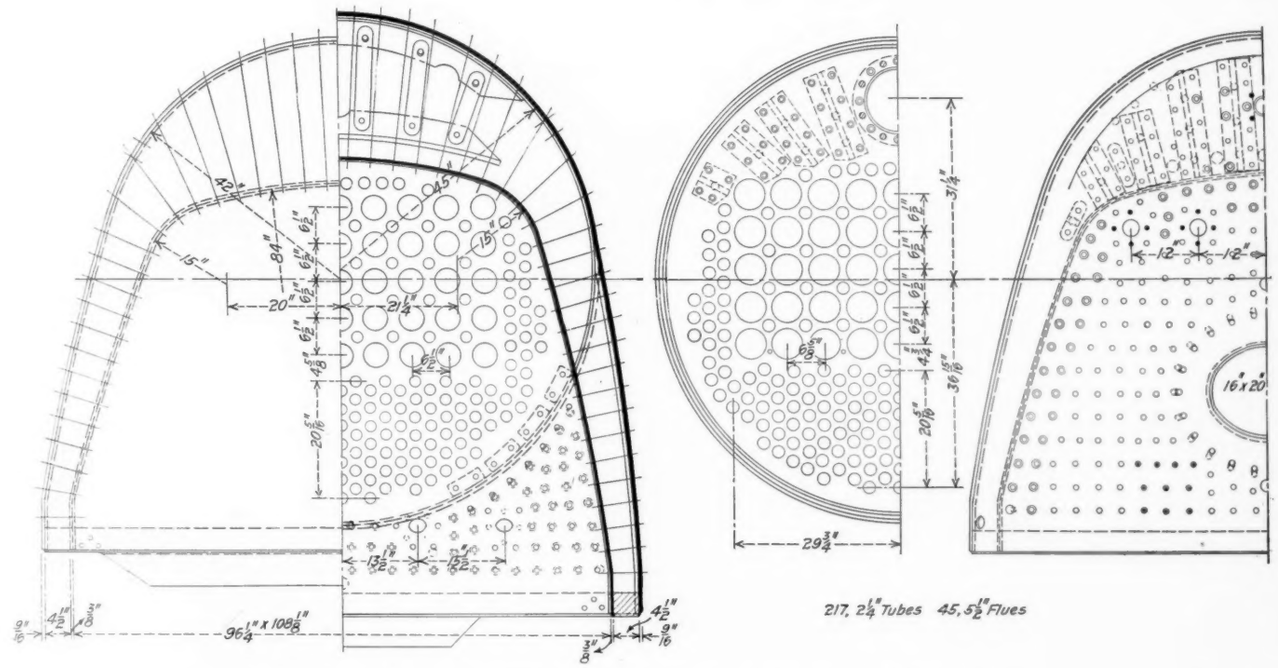
Extended Wagon Top Boiler for the Chesapeake & Ohio Ten-Wheel Switching Locomotive

support the heavy weight of the locomotive. The journals of the main driving axles are 11½ in. by 23 in. and the other four axles have journals 10½ in. by 14 in.

The cab fittings are arranged on the backhead in the most convenient location for the engineman and particular care has been taken to afford an unobstructed view in both directions from the cab.

The boiler is of the extended wagon top type with a wide firebox. It has an inside diameter of 88¼ in. at the dome course. The longitudinal seams are on the top center line, have inside and outside welt strips and are strongly riveted. The circumferential seams are lapped 5½ in. at the smokebox, with a double row of 1-in. rivets, 5¾-in. at the two intermediate seams, with double rows of 1¼-in. rivets and 5¼-in. at the firebox with a double row of 1⅛-in. rivets. The boiler is equipped with a Schmidt superheater, having a heating surface of 945 sq. ft. The firebox is 108⅛-in. long by 96¼ in. wide inside, has an average height of 72⅝-in. and a grate area of 72.2 sq. ft.

The tender tank is built unusually low and long and the side plates of the coal space are set in to permit an unobstructed view toward the rear. The tank is 32 ft. long by 10 ft. wide, by 5 ft. high inside, and has a water capacity of 15,000 gallons. The coal space has a capacity of 15 tons. The tender frame is of cast steel, having side sills 10 in. deep and intermediate sills 13 in. deep. The vertical webs of these sills are 1-in. thick and are very strongly ribbed and webbed, making a most rigid frame that will withstand any stress that may be put upon it in heavy switching service.

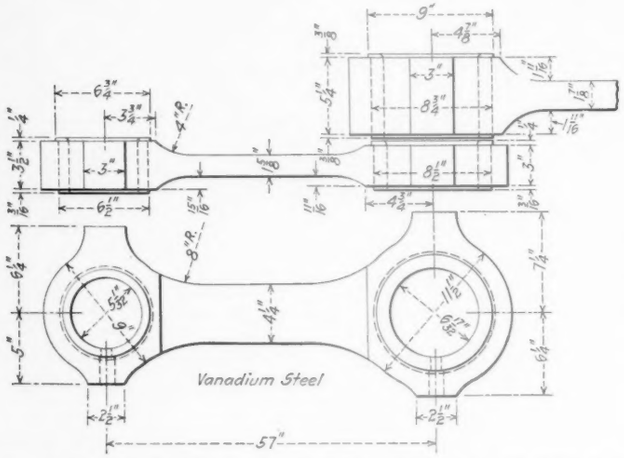


Cross Sections of Boiler for the Chesapeake & Ohio Heavy Switcher

The tender trucks are of the same design as those used under the tenders for the Chesapeake & Ohio Mallet type locomotives. The truck side frames are 6 in. wide and are

of cast steel. The bolsters are also of cast steel and are supported by triple elliptic steel springs. The wheel base is 5 ft. 10 in., and the wheels 33 in. in diameter and the journals 6 in. by 11 in.

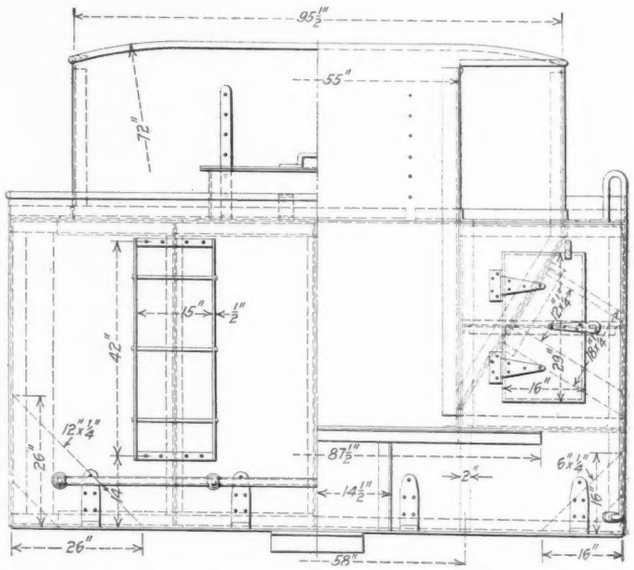
The specialties include the Cole long main driving boxes, Watters pneumatic sanders, Nathan lubricators and non-lifting injectors, Hancock combined stop and check valves and hose strainers, "Loco" incandescent headlight equipment,



Back Section Rod Outside of Side Rods and in Line with Main Rod

Consolidated safety valves, Franklin pneumatic grate shakers, Lewis power reverse gear, Economy radial buffer, Farlow-Westinghouse draft gear, Sharon tender and pilot couplers, Commonwealth cast steel pilot beam and tender frame, Hunt-Spiller gun iron cylinder and valve packing rings and steam chest bushings, Cambria Coffin process axles, Schmidt superheater and Westinghouse-American brakes with two 9½-in. pumps. The piston rods and crank pins, the frames and the main and side rods are of vanadium steel.

In the design and construction of these locomotives careful attention was given to the smallest detail so that the tractive effort might be a maximum without any unnecessary weight being added to the locomotive as a whole. The service obtained from them since they were placed in service in February, 1919, has been very satisfactory. They have not only handled the heavy trains easily but have proved to be as well adapted to a lighter switching service as the medium sized locomotives.

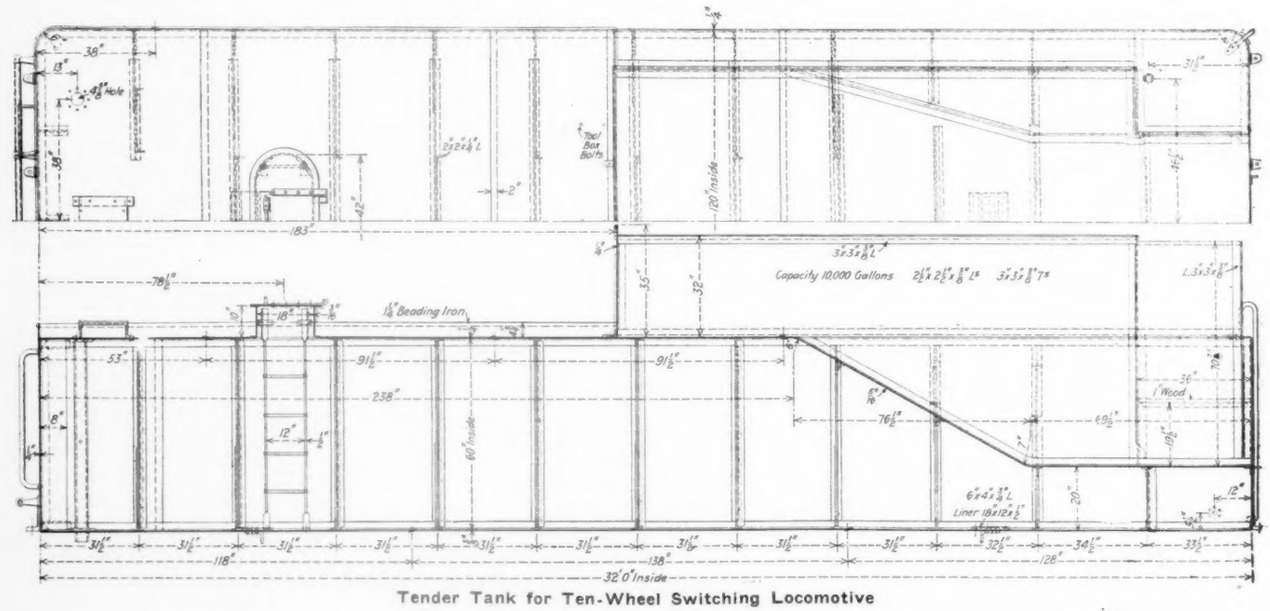


Half Front and Rear Elevations of Tender for C. & O. Ten-Wheel Switcher

The principal weights, dimensions and ratios are as follows:

General Data

Gage	4 ft. 8½ in.
Service	Switching
Fuel	Soft coal
Tractive effort	63,000 lb.
Weight in working order	295,000 lb.
Weight on drivers	295,000 lb.



Tender Tank for Ten-Wheel Switching Locomotive

Weight of engine and tender in working order	478,100 lb.
Wheel base, driving	19 ft.
Wheel base, total	19 ft.
Wheel base, engine and tender	60 ft. 3¼ in.

Ratios

Weight on drivers ÷ tractive effort	4.68
Total weight ÷ tractive effort	4.68
Tractive effort × diam. drivers ÷ equivalent heating surface*	629
Equivalent heating surface* ÷ grate area	70.5
Weight on drivers ÷ equivalent heating surface*	57.4

Total weight ÷ equivalent heating surface*	57.4
Volume both cylinders	18.55 cu. ft.
Equivalent heating surface* ÷ vol. cylinders	277
Grate area ÷ vol. cylinders	3.84
Cylinders	
Kind	Simple
Diameter and stroke	27 in. by 28 in.
Valves	
Kind	Piston
Diameter	12 in.
Greatest travel	6 in.
Wheels	
Driving, diameter over tires	51 in.
Driving journals, main, diameter and length	11½ in. by 23 in.
Driving journals, others, diameter and length	10½ in. by 14 in.
Boiler	
Style	Extended wagon top
Working pressure	185 lb. per sq. in.
Inside diameter of first ring	82 in.
Firebox, length and width	108⅛ in. by 96¼ in.
Tubes, number and outside diameter	217—2¼ in.
Flues, number and outside diameter	45—5½ in.
Tubes and flues, length	18 ft. 1 in.
Heating surface, tubes	2,300 sq. ft.
Heating surface, flues	1,166 sq. ft.
Heating surface, firebox†	232 sq. ft.
Heating surface, total	3,698 sq. ft.
Superheater heating surface	935 sq. ft.
Equivalent heating surface*	5,100.5 sq. ft.
Grate area	72.3 sq. ft.
Tender	
Tank	8-wheel
Frame	Cast steel
Weight	183,100 lb.
Wheels, diameter	33 in.
Journals, diameter and length	6 in. by 11 in.
Water capacity	10,000 gal.
Coal capacity	15 tons

*Equivalent heating surface = total evaporative heating surface + 1.5 times the superheating surface.
†Includes arch tubes.

ROLLING STOCK ORDERED AND BUILT IN 1919

New Low Records in Locomotive and Car Orders Production of Freight Cars Greater than in 1918

THE number of locomotives ordered for service in the United States during 1919, according to the statistics of the Railway Age, were only 214. This marks a new low record in the history of the railroads of the country. The orders placed by Canadian roads either with American or Canadian builders totaled 58, while orders for export reached a total of 898, a total of all three of but 1,170. In other words, the foreign orders and the domestic together were barely sufficient to bring the total up to the domestic orders alone of the poorest year since 1901, namely, 1908, when only 1,182 locomotives were ordered for domestic service.

TABLE I—THE LOCOMOTIVE ORDERS OF 1919

For service in the United States	214
For service in Canada	58
For export to other countries	898
Total	1,170

The 1919 totals quoted above compare with figures for 1918 of 2,593 for domestic service in the United States, 209 for Canadian roads and 2,086 for the American forces in France or for export. The total of locomotives ordered for domestic service represents only those locomotives ordered by lumber roads and industrial lines; there are but few orders for railroad service.

TABLE II—ORDERS FOR LOCOMOTIVES SINCE 1901

Domestic orders only

Year	Locomotives	Year	Locomotives
1901	4,340	1908	1,182
1902	4,665	1909	3,350
1903	3,283	1910	3,787
1904	2,538	1911	2,850
1905	6,255	1912	4,515
1906	5,642	1913	3,467
1907	3,482	1914	1,265

Domestic and Foreign

	Domestic	Foreign	Total
1915	1,612	850	2,462
1916	2,910	2,983	5,893
1917	2,704	3,438	6,142
1918	2,802	2,086	4,888

The number of locomotives built in the United States and Canada in 1919, according to the compilations of the Railway Age, was 3,272, of which 2,162 were built for domestic use and 1,110 for export. Of the domestic total 2,055 engines are shown as having been built in the United States for use on the railroads in this country and 107 in Canada for use in that country. The totals given are but one-half those of 1918, when 6,475 locomotives were produced in the United States and Canada. It will be noted, however, that the total domestic output of 1919 was considerably above that of the years immediately preceding 1918.

TABLE III—THE LOCOMOTIVES BUILT

	United States	Canada	Total
Domestic	2,055	109	2,162
Foreign	.....	.....	1,110
Total			3,272

Comparison with Previous Years

Year	Domestic	Foreign	Total	Year	Domestic	Foreign	Total
1896	866	309	1,175	1908*	1,886	456	2,342
1897	865	386	1,251	1909*	2,596	291	2,887
1898	1,321	554	1,875	1910*	4,441	314	4,755
1899	1,951	514	2,475	1911*	3,143	387	3,530
1900	2,648	505	3,153	1912†	4,403	512	4,915
1901	.....	.....	3,384	1913†	4,561	771	5,332
1902	.....	.....	4,070	1914†	1,962	273	2,235
1903	.....	.....	5,152	1915†	1,250	835	2,085
1904	.....	.....	3,441	1916†	2,708	1,367	4,075
1905*	4,896	595	5,491	1917†	2,585	2,861	5,446
1906*	6,232	720	6,952	1918†	3,668	2,807	6,475
1907*	6,564	798	7,362				

*Includes Canadian output.
†Includes Canadian output and equipment built in railroad shops.

FREIGHT CARS ORDERED AND BUILT

The number of freight cars ordered for domestic service in the United States in 1919 totaled only 29,893, marking a figure so low as to make almost ridiculous a comparison with the domestic orders of previous years. There were ordered for service in Canada 3,837 freight cars and for export to other countries 3,994. These totals compared with domestic orders placed in 1918 for cars to be used in the United States of 114,113; for roads in Canada, 9,657, and for the A. E. F. and for export to other countries, 53,547.

TABLE IV—THE FREIGHT CAR ORDERS OF 1919

For service in the United States*	22,062
For service in Canada	3,837
For export to other countries	3,994
Total	29,893

*Including 15,295 tank cars.

The exceptionally small domestic total in 1919 resulted from the fact that the United States Railroad Administration has placed no orders for cars in 1919 and that the railroads have ordered but a very few. In fact, the larger part of the orders that have been reported have been placed by private car lines, over two-thirds of the orders being for tank cars.

The orders for export, totaling in the neighborhood of but 4,000, were considerably below the totals of 1917 and 1918. They were less than one-fourth as great as those for 1915, the year in which the war demands began to make themselves effective. They were less than one-twelfth as great as in 1918. The domestic, Canadian and foreign orders combined

TABLE V—ORDERS FOR FREIGHT CARS SINCE 1901

Domestic orders

	Freight cars		Freight cars
1901	193,439	1908	62,669
1902	195,248	1909	189,360
1903	108,936	1910	141,024
1904	136,561	1911	133,117
1905	341,315	1912	234,758
1906	310,315	1913	146,732
1907	151,711	1914	80,264

Domestic and foreign

Year	Domestic	Foreign	Total
1915	109,792	18,222	128,014
1916	170,054	35,314	205,368
1917	79,367	53,191	132,558
1918	123,770	53,547	177,317

were only slightly over one-third as great as the domestic orders alone in the poorest year since 1901, namely, 1908, when but 62,669 cars were ordered for domestic service.

The production of freight cars in the United States in 1919 has totaled 156,764, of which 94,981 were for domestic service and 61,783 were for export. The total of 156,764

TABLE VI—FREIGHT CARS BUILT

	United States	Canada	Total
Domestic	94,981	6,391	101,372
Foreign	61,783	30	61,813
	156,764	6,421	163,185

Comparison with Previous Years

Year	Freight Domestic	Foreign	Total
1899	117,982	1,904	119,886
1900	113,070	2,561	115,631
1901	132,591	4,359	136,950
1902	161,747	2,800	162,599
1903	153,195	1,613	152,801
1904	60,955	1,995	60,806
1905*	162,701	5,305	165,155
1906*	236,451	7,219	240,503
1907*	280,216	9,429	284,188
1908*	75,344	1,211	76,555
1909*	91,077	2,493	93,570
1910*	176,374	4,571	180,945
1911*	68,961	3,200	72,161
1912†	148,357	4,072	152,429

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
	Domestic	Foreign	Total	Domestic	Foreign	Total	total
1913	176,049	9,618	185,667	22,017	.....	22,017	207,684
1914	97,626	462	98,088	6,453	.....	6,453	104,451
1915	58,226	11,916	70,142	1,758	2,212	3,970	74,112
1916	111,516	17,905	129,421	.....	.....	5,580	135,001
1917	115,705	23,938	139,643	3,658	8,100	11,758	151,401
1918	67,063	40,981	108,044	14,704	1,960	16,664	124,708

represents by no means as large a share of the productive capacity of the country as might be wished. It is, however, considerably in excess of the output of the car-building plants of the United States of 108,044 (124,708 including Canada) in 1918, or of 139,643 (151,401 including Canada) in 1917. In fact, it has been exceeded but twice since the big total of 284,188 (including Canada) in 1907, namely, in 1910, when there were produced in the United States and Canada 180,915 cars, and in 1913, when 207,684 were produced.

The unfortunate feature in the comparatively large output figures of 1919 is the small number for domestic use. While the total output is large, it will be noted that that for domestic use alone, while it is above the level of 1918, when 67,063 cars were produced for use in the United States, is not up to the totals of 1916 or 1917 even, in which years the output of freight cars was not sufficient to keep up with the increasing demands of the business offered for railway transportation.

FEW PASSENGER CARS BUILT IN 1919

The figures showing the new orders and the production of passenger cars in 1919 indicate that that industry has as yet by no means recovered from the practical cessation of business resulting from the war and its attending circumstances. The number of passenger cars ordered

TABLE VII. THE PASSENGER CAR ORDERS OF 1919

For service in the United States	292
For service in Canada	347
For export to other countries	143
Total	782

in 1919 totaled 782, of which 292 were for service in the United States, 347 for Canada and 143 for export. Owing to the fact that there have been a number of passenger car orders placed within the last few weeks these numbers are considerably in excess of those of 1918, when 131 cars were

TABLE VIII. ORDERS FOR PASSENGER CARS SINCE 1901

Domestic orders only

	Passenger cars		Passenger cars
1901	2,879	1909	4,514
1902	3,459	1910	3,881
1903	2,310	1911	2,623
1904	2,213	1912	3,642
1905	3,289	1913	3,179
1906	3,402	1914	2,002
1907	1,791	1915	3,101
1908	1,319		

Domestic and Foreign

Year	Domestic	Foreign	Total
1916	2,544	109	2,653
1917	1,124	43	1,167
1918	131	26	157

ordered for domestic service and 26 for export, but, of course, they are not at all up to the totals for 1917.

The production of passenger cars in the car building plants of the United States in 1919 (excluding Canada), totaling 466, of which 306 were for domestic use and 85 for export, is likewise far below the output for 1918, when 1,573 cars were built, including 1,481 cars for domestic use and 92 for export. The output of passenger cars in 1919 was the lowest since the compilation of these figures was begun.

TABLE IX. PASSENGER CARS BUILT

	United States	Canada	Total
Domestic	306	160	466
Foreign	85	...	85
	391	160	551

Comparison with Previous Years

Year	Passenger Domestic	Foreign	Total
1899	1,201	104	1,305
1900	1,515	121	1,636
1901	1,949	106	2,055
1902	From 1902 to 1907 passenger		1,948
1903	car figures in these two		2,007
1904	columns included in corre-		2,144
1905*	sponding frt. car columns.		2,551
1906*	.....	...	3,167
1907*	.....	...	5,457
1908*	1,645	71	1,716
1909*	2,698	151	2,849
1910*	4,136	276	4,412
1911*	3,938	308	4,246
1912†	2,822	238	3,060

*Includes Canadian output.
†Includes Canadian output and equipment built in company shops.

	United States			Canadian			Grand
	Domestic	Foreign	Total	Domestic	Foreign	Total	total
1913	2,559	220	2,779	517	.....	517	3,296
1914	3,310	56	3,366	325	.....	325	3,691
1915	1,852	14	1,866	83	.....	83	1,949
1916	1,732	70	1,802	37	.....	37	1,839
1917	1,924	31	1,955	45	.....	45	2,000
1918	1,480	92	1,572	1	.....	1	1,503

The orders on hand for passenger cars at present promise a somewhat larger year from the production standpoint in 1920 than in 1919.

DEVELOPMENTS IN THE SHOP LABOR SITUATION

Summary of Reports Showing Changes in Wages and Hours of Various Classes of Employees since 1917

THE United States Railroad Administration has prepared very complete reports of the number of employees, rates of pay and the average of compensation in December, 1917, and each month from January to July, 1919, at the request of the Senate. This information was submitted to the president of the Senate by Director General Hines, and a summary of the data relating to the shop crafts is shown in the tables below.

There has been a widespread belief that there was a considerable increase in the number of railway employees and the total number of hours worked. The report shows, however, that while more employees are now used for a similar amount of work, the increase has resulted largely from the effect of the introduction of the eight-hour day in reducing the number of hours worked by each employee. Considering all classes of employees, the number employed by the railroads under government control increased from December, 1917, to July, 1919, by 11.2 per cent, as shown in the following table. During this same period the number of hours worked decreased 3.9 per cent and the total compensation increased 36 per cent.

Considering only the shop crafts, the average increase in the number of employees has been 19.2 per cent. The change in the average number of hours worked per employee varies greatly for the different classes. The general foremen were the only class showing an increase, the average number of days worked in July, 1919, being 29.9 per cent as compared with 27.1 per cent in December, 1917. On the other hand, the average number of hours worked by hostlers during July, 1919, was 97 hours less than in December, 1917, and by car inspectors 89 hours less. The average increase in the unit compensation for all classes of employees was 53 per cent. The increases for shop crafts in most cases were considerably greater. Taking into account the increase granted in September, 1919, the rate of pay for car inspectors increased 117 per cent. The only classes of employees in the mechanical department receiving less than the average percentage of increase were the machinists, boilermakers and blacksmiths. It should be noted in this connection that these crafts are among the highest paid classes of railroad employees, and although they have not received increases proportionate to the other crafts this is quite consistent with the

NUMBER OF EMPLOYEES AND AVERAGE HOURS WORKED

Class 1 Roads Under Federal Control December, 1917, and July, 1919

Class of Employee	Number of employees December, 1917	July, 1919	Increase or Decrease	Average hours worked per employee: July, 1919	Average hours worked per employee: December, 1917	Decrease or Increase
General foreman, M. E. department	1,665	1,707	42	days 29.9	days 27.1	Inc. 2.8
Gang and other foremen, M. E. department	18,429	23,592	5,163	days 28.4	days 28.9	.5
Machinists	42,973	59,067	16,094	206	248	42.
Boiler makers	13,469	18,413	4,944	213	253	40.
Blacksmiths	8,369	9,898	1,529	200	224	24.
Painters and upholsterers	9,878	12,632	2,754	194	225	31.
Electricians	9,894	13,200	3,306	days 26.8	days 29.0	2.2
Air-brake men	5,846	7,781	1,935	217	280	63.
Car inspectors	20,763	24,258	3,495	239	328	89.
Car repairers	66,443	80,417	13,974	209	240	31.
Mechanics' helpers and apprentices	92,018	107,263	15,245	208	251	43.
Hostlers	8,493	10,687	2,194	240	337	97.
Enginehouse men	60,439	68,685	8,246	250	318	68.
Carpenters	50,848	50,854	6	201	234	33.
Total	409,527	488,454	78,927			

This report is compiled according to the classification prescribed by the Interstate Commerce Commission in accordance with the Act to regulate commerce, which classification has been the prescribed form since July 1, 1915.

The classification of employees prescribed by the Interstate Commerce Commission and used in the reports, does not correspond with the classification of employees used in the wage orders of the Railroad Administration, with the result that employees in a given class (of wage orders) receiving either higher or lower wages may be included with the employees of another class (of the Interstate Commerce Commission classification).

A comparison of the number of employees in January, 1919, and December, 1917, is misleading, because in December, 1917, on account of the extreme cold weather, much outside work had of necessity to be suspended. In addition, there was a scarcity of labor, in consequence of the competition of war industries, and the generally higher wages paid by them which had attracted many employees from railroads.

On the contrary, the weather was exceptionally mild in January, 1919, and permitted the prosecution of an unusual amount of outdoor work; moreover, the labor supply was relatively greater because of higher wages, and in consequence of the cessation of war activities. In addition, the Railroad Administration had not yet been able fully to reduce its forces from what had been necessary to handle the peak load which was reached about the time of the signing of the armistice a couple of months earlier.

In considering the number of employees in view of the changes in the working conditions between 1917 and 1919, the number of hours worked should be carefully noted.

DAILY AND HOURLY RATES OF PAY—CLASS I ROADS UNDER FEDERAL CONTROL

Class of employee	Compensation: Per day: July 1919	Per day: December 1917		Per hour: July 1919	Per hour: December 1917		Per cent Change in unit Compensation
General foremen, M. E. department	8.68	5.00	....	....	....	....	74
Gang and other foremen, M. E. Department	6.88	4.23	....	....	....	....	63
Machinists	....	....	*.730*	.690	.509	*43*	36
Boiler makers	....	....	*.734*	.695	.504	*46*	38
Blacksmiths	....	....	*.734*	.695	.504	*46*	38
Carpenters	....	....	*.657*	.584	.350	*88*	67
Painters and upholsterers	....	....	*.676*	.611	.382	*77*	60
Electricians	.538	3.22	....	....	....	*77*	67
Air-brake men	....	....	*.651*	.611	.459	*81*	70
Car inspectors	....	....	*.700*	.610	.323	*117*	89
Car repairers	....	....	*.663*	.591	.366	*81*	61
Mechanics' helpers and apprentices	....	....	....	.457	.296	....	54
Hostlers	....	....	....	.553	.329	....	68
Enginehouse men	....	....	....	.419	.242	....	73

Note—Italic figures indicate estimate of increase to shopmen in September, 1919, retroactive to May 1, 1919.

original policy of the wage board, which recommended increases on a graduated scale.

It should be noted, also, that a comparison between the rates of pay in 1919 with the single month of December, 1917, is likely to be misleading, because some classes of employees had prior to December, 1917, obtained reductions in hours which resulted in their average compensation per hour being substantially increased, or increases in rates of pay, or both, whereas other classes of employees secured corresponding treatment only after December, 1917.

	Number of employees	Increase in percentages as compared with December, 1917
1917—December	1,703,748	...
1919—January	1,848,774	8.5
February	1,840,197	8.0
March	1,823,220	7.0
April	1,830,093	7.4
May	1,864,561	9.4
June	1,863,741	9.4
July	1,894,287	11.2

The records do not indicate separately the amount of punitive overtime, but it is probably true that in December, 1917, numerous classes of employees were working punitive overtime to a larger extent than in July, 1919.

	Total number of hours worked	Increase in percentage as compared with December, 1917
1917—December	434,252,656	...
1919—January	440,699,731	1.5% increase
February	375,204,721	13.6% decrease
March	398,689,315	8.2% decrease
April	393,578,428	9.4% decrease
May	409,674,681	5.7% decrease
June	396,385,011	8.7% decrease
July	417,182,290	3.9% decrease

Based on comparisons between December, 1917, and July, 1919, Director General Hines reported that the average percentage of increase in the unit compensation for all railroad employees was 53 per cent, which would be increased to approximately 56 per cent by including the shopmen's increase, but that because of the reduction in hours the average increase in monthly compensation was 32.9 per cent or 35.3 per cent, taking into consideration the shopmen's increase. The wages in December, 1917, were, however, on a higher basis than the average for that year, because of the large number of increases made by the railroads during the last year of private management, and the increase for July, 1919, over the average for 1917 was given by Mr. Hines as 45.3 per cent.

	July, 1919	December, 1917
Number of employees	1,894,287	1,703,748
Days worked	6,122,435	5,819,486
Hours worked	368,202,810	387,696,788
Total compensation	$226,140,935	$153,039,988
Average compensation per day for employees reported on a daily basis	4.93	3.52
Average compensation per hour for employees reported on an hourly basis	.532	.342

Per cent of increase for July, 1919, over December and calendar year 1917, 35.3 per cent.

REPORT ON COST OF LIVING DOES NOT JUSTIFY WAGE INCREASE.

Executive officers of the railroad shop crafts affiliated with the Railroad Employees' Department of the American Federation of Labor called on Director General Hines on December 20, just before the Cummins bill was passed by the Senate, to discuss, according to a statement issued by the Railroad Administration, "the question of the cost of living," which is taken to mean that they renewed their request for a general increase in wages which has been held in abeyance since August, when the President and Mr. Hines asked them to wait a reasonable time to allow the government an opportunity to try to reduce the cost of living. According to the official announcement, Mr. Hines explained that he hoped to be able in a few days to give more definite advice on this subject, and it was agreed that a further conference would be held a few days later.

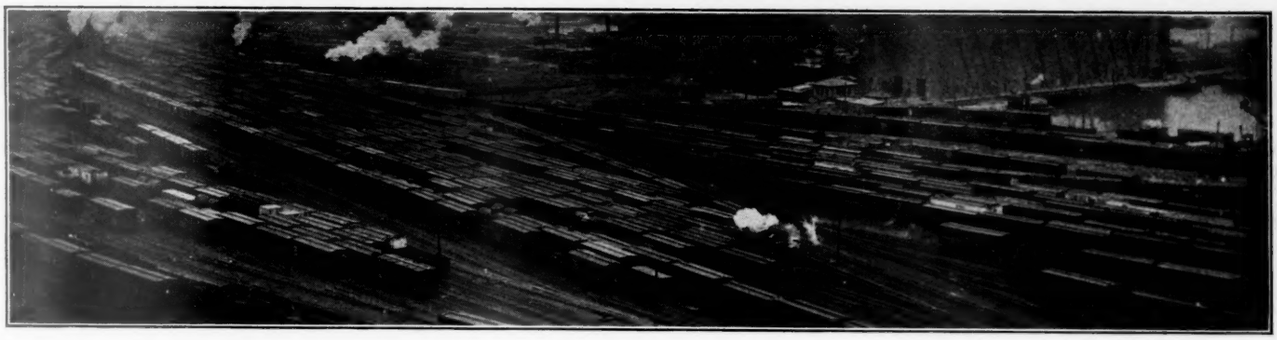
On December 22 Attorney General Palmer issued a statement in the way of a report to the public on the results of the government's campaign against the high cost of living, in which he announced that since August it had been held in check, whereas statistics had usually shown a rise in prices during the fall months and that a drop may be expected between January 1 and March 1. The report, which was authorized by a committee of government officials that have taken part in the campaign, including Mr. Hines, is understood to form the basis of the government's answer to any further wage demands.

The demands of the shop employees were originally presented in January and were based on an increase for skilled mechanics from 68 to 85 cents an hour. Increases ranging from 4 to 9 cents an hour were granted them in August by way of readjustment at the time. It was announced the government could not then consider further increases to meet the cost of living, because they would tend to increase it still further. Most of the other organizations of railway employees also presented demands, which have also been held in abeyance. What position they will take in view of the report that the cost of living statistics do not justify further increases has not yet been disclosed. It was stated that no definite date had yet been set for the conference with the shopmen, but B. M. Jewell, head of their committee, was quoted as saying they had no intention of striking.

Average Monthly Compensation and Average Days or Hours Worked Per Employee
Class I Roads Under Federal Control
July, 1919, Compared with December, 1917, and Monthly Average for Calendar Year, 1917

Class of employee	Average monthly compensation per employee: July, 1919	December, 1917	Calendar year 1917	Per cent increase July, 1919, over: December, 1917	Monthly average for calendar year, 1917	Average hours worked per employee: July, 1919	December, 1917
General foremen—M. E. Department	259.51	135.69	138.37	91.3	87.5	*d*29.9	*d*27.1
Gang and other foremen—M. E. department	195.41	122.26	112.64	59.8	73.5	*d*28.4	*d*28.9
Machinists	142.18	126.11	116.20	12.7	22.4	206	248
Boiler makers	147.74	127.67	118.76	15.7	24.4	213	253
Blacksmiths	136.35	110.92	104.84	22.9	30.1	200	224
Carpenters	117.30	81.70	78.35	43.6	49.7	201	234
Painters and upholsterers	118.64	85.89	79.22	38.1	49.8	194	225
Electricians	143.97	93.59	75.84	53.8	67.7	*d*26.8	*d*29.0
Air-brake men	132.37	100.59	90.53	31.6	46.2	217	280
Car inspectors	145.71	106.03	95.02	37.4	53.3	239	328
Car repairers	123.33	87.77	82.81	40.5	48.9	209	240
Mechanics' helpers and apprentices	95.13	74.17	68.52	28.3	38.8	208	251
Hostlers	132.73	110.80	103.73	19.8	28.0	240	337
Enginehouse men	104.55	76.83	69.56	36.1	50.3	250	318

Note—*d* indicates days worked.



THE INSPECTION OF FREIGHT EQUIPMENT

First of a Series of Articles Describing the System of Handling Inspection Used on the C. M. & St. P.

BY L. K. SILLCOX
Master Car Builder, Chicago, Milwaukee & St. Paul

THESE instructions, effective date of issue, supersede all previous or heretofore existing regulations, and shall not be modified or revised, except by authority of the undersigned.

Car foremen will be held individually responsible for the enforcement of these instructions, and are to notify the master car builder in case any condition arises wherein they find it impractical or impossible to maintain the regulations as set forth.

GENERAL.

The data which follows has been worked up through the co-operation of the transportation department, the operating department and all concerned, having one purpose in mind; namely, the safe and prompt movement of freight equipment. The conclusions reached as set forth are the results of years of experience and the best judgment of the combined effort of those interested on the railroad. It is, therefore, necessary and obligatory that these instructions shall be lived up to literally, and no excuse whatever will be accepted for disregard of them. Good judgment is necessary in putting these regulations into practice.

Knowing that certain things must be done, and issuing instructions to do them, does not always mean they will be carried out or that the instructions issued will be complied with. Something more is required. The men in charge must be capable not only of issuing instructions, but capable of knowing whether these instructions are being complied with or not, and they should also be capable of turning the interpretation over to their assistants in workable form and selecting men who are capable of complying with these regulations.

If this statement is true, then we should have thorough capable and efficient foremen in charge of all stations who know when a car is inspected and how to inspect it as well. They should know when a car is properly repaired and how to repair it. If they are capable of doing this they should then be capable of selecting the right man to see that this work is properly performed, and so on right down to the point of seeing positively that neglect and inefficiency are never allowed to creep into the service.

Inspectors should be given trains to handle, as outlined on the charts on page 21, and they must be permitted to hold them a sufficient length of time to give each car the needed inspection and repairs or to shop defective cars out for repairs. After an inspector has shopped a car for defects which make it unsafe to be continued in service, no one should be permitted to cause such a car to be placed back in service until the repairs for which the car was shopped have been properly made, or improper repairs corrected. One giving or assuming such authority would by his act destroy the effort made toward obtaining safe movement and would be a promoter of ill results. It should be considered just as serious and dangerous for one to remove a bad-order card from a defective car and permit it to go into service without necessary repairs being made, or permit a car to go into service with a bad-order card on it without the repairs being made, as it would be for one to change a signal in front of an approaching train operating under the automatic block system.

Cars once inspected and passed as being fit for service should be in such condition that when inspected again at the next inspection point they will not be shopped out for defects that existed at the time of previous inspection, neither should they fail while in movement due to such defects; in other words, should an inspector pass a car as being safe and fit for loading at Chicago, that car should be in condition to continue through to Tacoma or any other destination without being shopped out or breaking down in movement, due to defects existing when the car was inspected at Chicago. When a car is repaired on the shop tracks at Minneapolis for movement to Omaha for loading, it should not be necessary to shop it for defects that existed when it was placed on the shop tracks, or for improper repairs made at Minneapolis, on or before its arrival at Omaha. No car should be placed for loading until first inspected and given needed repairs. Unless we are able to obtain these desirable conditions, our inspection or our repairs are not uniform, or our supervisors are not capable or efficient, or some one is removing bad-order cards or causing cars to leave inspection or repair yards before they are in proper condition for service.

Such practices, if they do exist, must be corrected or we cannot expect to establish the results which are required for safe and economical operation. Uniform inspection and repairs mean less loss of life and limb of passengers and trainmen, greater car mileage, fewer accidents, less destruction of equipment and property, less repeated shopping of cars, greater car supply, less need for the purchase of new equipment, decreases in the cost of operation and maintenance, prompt handling of business, greater satisfaction to shippers, better earnings for railroads and a more satisfactory dividend for stockholders.

EXAMINATION OF CAR INSPECTORS

A copy of these instructions will be issued to all car inspectors. They will be examined by their respective foremen, general foremen or district general car foremen. Inspectors are required to sign an acknowledgement as having received and understood these instructions, and all foremen or chief inspectors will keep complete information of this in their offices for present and any future employees of this class on the following form:

Record of Examination of Freight Car Inspectors

Name ..... Inspector at ..... Station, has been examined for (kind) ..... Car Inspector. Answered correctly on first examination ....., or ..... per cent, out of ..... questions put to him.

Answered correctly on second examination ....., or ..... per cent, out of ..... questions put to him.

Answered correctly on third examination ....., or ..... per cent, out of ..... questions put to him.

OK to be shown opposite numbers of questions answered correctly, and *X* after numbers of questions answered incorrectly. After second or third examination, the questions marked *X*, if answered correctly, will be marked *OK*.

QUESTION NUMBERS

Under Question Numbers the question should be given with ample space provided for the proper marking on standings.

Examined by.....
Car Foreman.
.....
General Car Foreman.
.....
Asst. M. C. B. or Dist. G. C. F.

QUALIFICATIONS OF FREIGHT CAR INSPECTORS

A—Applicant to be eligible as car inspector must have one year or more experience in the car department as a car repairman or builder.

B—The applicant must be between the ages of 21 and 45 years.

C—The applicant must pass the examination for sight and hearing.

D—The applicant must be able to read manuscript and print.

E—The applicant must write all answers to questions as shown in the examination, after he has studied them for at least 30 days.

F—The applicant must answer 75 per cent of the questions of the examination orally from memory.

G—The applicant if failing in the first examination may be examined again in 30 days.

H—The applicant failing in the second examination may again be examined for a third time within 30 days.

I—The applicant failing for the third time will not be considered eligible as an inspector.

J—A record of examination of the applicant will be kept in the file of the local car foreman for reference.

K—No inspector will be permitted to remain in service as an inspector unless he has complied with the above requirements.

L—Examination of car inspectors will be made by the car foreman, general car foreman, district general car foreman or assistant master car builder.

EXAMINATION QUESTIONS FOR FREIGHT CAR INSPECTORS

1. Q—What are the duties of a car inspector?

Answer—To inspect all cars, keep such records as he may receive instructions to keep from proper officers, and to see that no cars are allowed to go forward which have defects which render them unsafe or that have any Interstate Safety Appliance defects, and when not engaged in inspecting to repair and assist in making such repairs to the equipment as is needed to improve its condition.

2. Q—What is the most important duty of an inspector?

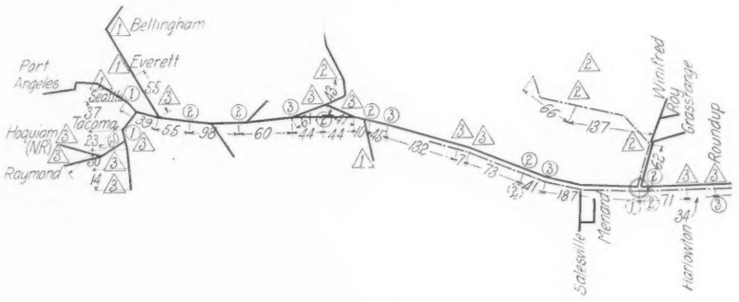
Answer—To see that cars and lading are in a safe and proper condition to go forward over the route they are intended to pass.

3. Q—What parts of a car require the most careful inspection?

Answer—Wheels for various defects, especially seams in the throat of the flange, loose wheels, arch bars, column bolts and nuts, foundation brake gear, including the condition of hangers, cotter keys and pins, ratchet pawls, keys and wheels, draft or pulling attachments, doors and roofs of box and other house or stock cars. The lading, especially where its safe movement depends on blocks, stakes, wires and other fastenings, or is improperly distributed and liable to contribute to derailments or heated journals. Also all safety appliance defects, as covered by the interstate laws, journal box bolts and nuts, journal bearings, journals, axles and lubrication.

4. Q—Are the parts mentioned above the only ones which should receive careful attention when inspecting cars?

Answer—No. All parts of a car should be given attention and consideration, as it is well known that a nut or cotter key missing from certain parts of cars of some construction permits parts to fall on the track, that might cause an accident and be attended with a considerable loss of property, if not loss of life.



5. Q—Why is special mention made of seams in the throat of wheel flanges and loose wheels?

Answer—These defects are at times very difficult to discover and frequently cause serious and expensive accidents.

6. Q—Why are arch bars, column bolts and nuts mentioned?

Answer—It is well known that it often happens that a very small crack or fracture in an arch bar results in its failure. A broken column bolt or nuts missing from the column bolt allows the bars to distort and fail, which frequently cause accidents.

7. Q—Why are foundation brake gear and certain derailed parts mentioned?

Answer—For the reasons given in the answer to Question No. 4, also for the reason that if the foundation brake gear should become disconnected the brake would be inoperative, and if the foundation brake gear should be too low when the car is loaded it will strike switch rails and crossings and might cause an accident or a derailment. In addition, the hand brakes should be maintained in a good operative condition at all times, so that when a car is being handled alone its speed can be controlled by the use of hand brakes.

8. Q—Why is mention made of draft or pulling attachments?

Answer—It is necessary that certain essential parts of the various forms or types of such attachments be maintained to a certain standard of efficiency to insure safe movement of the car.

9. Q—Why are doors and roofs of box and other house or stock cars mentioned?

Answer—Doors and fixtures frequently become defective, to the extent that the doors are liable to swing out and strike a passing train or fall on the track, and roofs, on account

of faulty construction or decay or age, are liable to be blown off and fall on the track and cause an accident.

10. Q—Have you any detailed instructions relative to the way the different character of lading should be placed on cars and secured to insure its safe movement over railroads?

Answer—Yes. The latest revised "Rules Governing the Loading of Stone, etc., Loading and Carrying of Structural Materials, Plates, Rails, Girders, etc.," as prescribed by the Master Car Builders' Association.

11. Q—Where it is found that these rules and cuts do not apply to lading being prepared for shipment, what should be done?

Answer—Special instructions must be asked for.

12. Q—Do you understand that railroads are liable to a fine for hauling cars with Safety Appliance Act defects?

Answer—I do.

13. Q—What do the Safety Applicance Act defects consist of?

Answer—Defective couplers and parts that make the couplers inoperative to the extent that they will not couple in impact, or if the coupler is less than 31½ inches or more than 34½ inches from the top of the rail to the center line of the coupler shank, defective uncoupling mechanism, hand or air brakes, hand holds, steps, ladders, running boards or other parts covered, and to be found in the rules for the inspection of safety appliances.

16. Q—Is there any other information concerning air brakes, their operation and maintenance that it is important that inspectors become familiar with?

Answer—Yes. The air brake rules, which treat on the details of this subject, contain important information that each inspector should become familiar with.

17. Q—What piston travel should be maintained on car equipment?

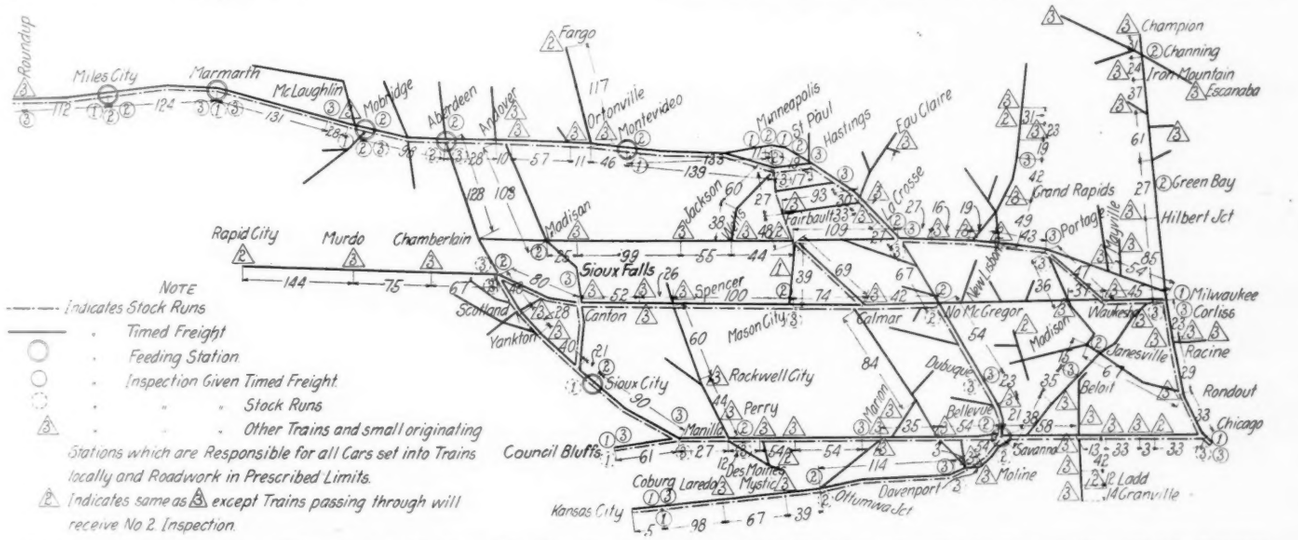
Answer—On cars equipped with automatic slack adjusters it should not be less than 7 in. nor more than 8 in. when the car is standing.* When brakes are applied on cars not equipped with automatic slack adjusters the piston travel must be from 5 in. to 7 in., and in adjusting piston travel it should be 6 in., as per rules and regulations governing air brakes and air signals.

18. Q—What is the underlying idea or principle of the Master Car Builders' Association rules?

Answer—To facilitate the interchange of cars; to establish uniformity of practice in inspecting and repairing them, and in rendering bills for such repairs. Also to make car owners responsible for and chargeable with repairs to their cars necessitated by ordinary wear and tear in fair service.

19. Q—When is a company operating the cars of another company responsible for defects on such cars?

Answer—When the defects are due to unfair usage, derailment or accident, and for improper repairs made by it to



The Lines of the Chicago, Milwaukee & St. Paul, Showing the Through Freight Runs and the Class of Inspection Division Points

14. Q—Why is it essential that journal boxes, journal bearings, axles and lubrication be maintained in good condition?

Answer—To prevent failures of such parts in service and the expense and delay to cars and freight on account of setting out cars on the line for repairs.

15. Q—What attention should inspectors give to air brakes?

Answer—They should see that the air hose, pipes and other parts are maintained in such condition as to keep the brakes in good operative condition; that the brake cylinders, triple valves, high speed reducing valves, slack adjusters, safety valves and dirt collectors are cleaned on all cars, as provided for in the Master Car Builders' Association Code of Rules or other existing instructions.

Supplementary reservoirs on passenger train cars equipped with the LN brake equipment must be cut in when such cars are in passenger trains, but supplementary reservoirs must be cut-out when passenger train cars equipped with the LN equipment are put in freight trains.

such cars; also for certain other improper repairs, which are provided for in the M. C. B. rules.

20. Q—What cars must be accepted in interchange?

Answer—All cars that are in safe and serviceable condition that are free from any safety appliance defect and otherwise meet the requirements of the M. C. B. rules.

21. Q—Who is to be the judge of the safe and serviceable condition of cars offered in interchange?

Answer—The receiving road in all cases not specifically provided for in the M. C. B. rules.

22. Q—Under what condition would you, as delivering inspector, issue an M. C. B. defect card?

Answer—When the company which I represent is responsible for defects according to the M. C. B. rules for which a card is requested.

23. Q—Under what condition would you refuse to issue a defect card?

Answer—If the owner of the car is responsible under the

*This is added as a word of caution when passenger train cars are employed in freight train service.

M. C. B. rules for the defects for which the card is requested to cover.

24. Q—When should a bad-order card be attached to a car?

Answer—In every instance that the car or lading is found to be defective.

CARS AT ORIGINATING POINTS.

(Referring principally to stations, Chicago, Milwaukee, Omaha, Kansas City, Coburg, Council Bluffs, Minneapolis, St. Paul, South St. Paul, Aberdeen, Mitchell, Sioux City, Rapid City, Mobridge, Spokane, Seattle, Tacoma and all originating stations.)

A daily inspection should be made of every freight car standing in yards, industry tracks or at loading stations at all points on the railroad where carmen are stationed. Where conditions will permit, each inspector should be assigned to a particular part of this work. Defects discovered should be either repaired at once or so marked that they will be readily noted by car repairers or box packers, in cases where car inspectors cannot handle the work due to local conditions. The maximum time trains may be held for Class No. 1 inspection is five hours, less time when possible. Cars are to be set out if the work cannot be completed in this period, provided it is desired to move the train. The following will be some of the work necessary in placing trains in proper condition at No. 1 stations:

CLASS 1 INSPECTION.

Class No. 1 inspection, otherwise known as originating or initial inspection and repairs to equipment coming empty or loaded to our lines, also covering the necessary action on loaded equipment before leaving the initial point of loading.

The greatest responsibility we hold as a department is with respect to seeing that we have as nearly a perfect car for any particular lading or routing over our lines as possible, and also to see that the load is so placed in the car by the consignor that it does not cause damage to the car or itself, thereby co-operating to the extent of having the shipment and equipment reach its destination and the consignee in the condition and time that it should, thus overcoming unnecessary expenditures and complaints from shippers. For this reason there must be the very closest co-operation between all employees of this department and those who are placing the loads in the car, both at freight houses, industrial plants and all other similar loading points, to see that the M. C. B. rules are strictly observed, both in open and closed cars, to protect the lading en route against shifting and otherwise, and also on double and triple loads, to see that they are carefully built up to insure safe movement in line with current M. C. B. loading rules. These rules, as in effect, are revised from year to year and are perfected to cover the interchange of equipment throughout the country.

It is important to remember to give close attention to the

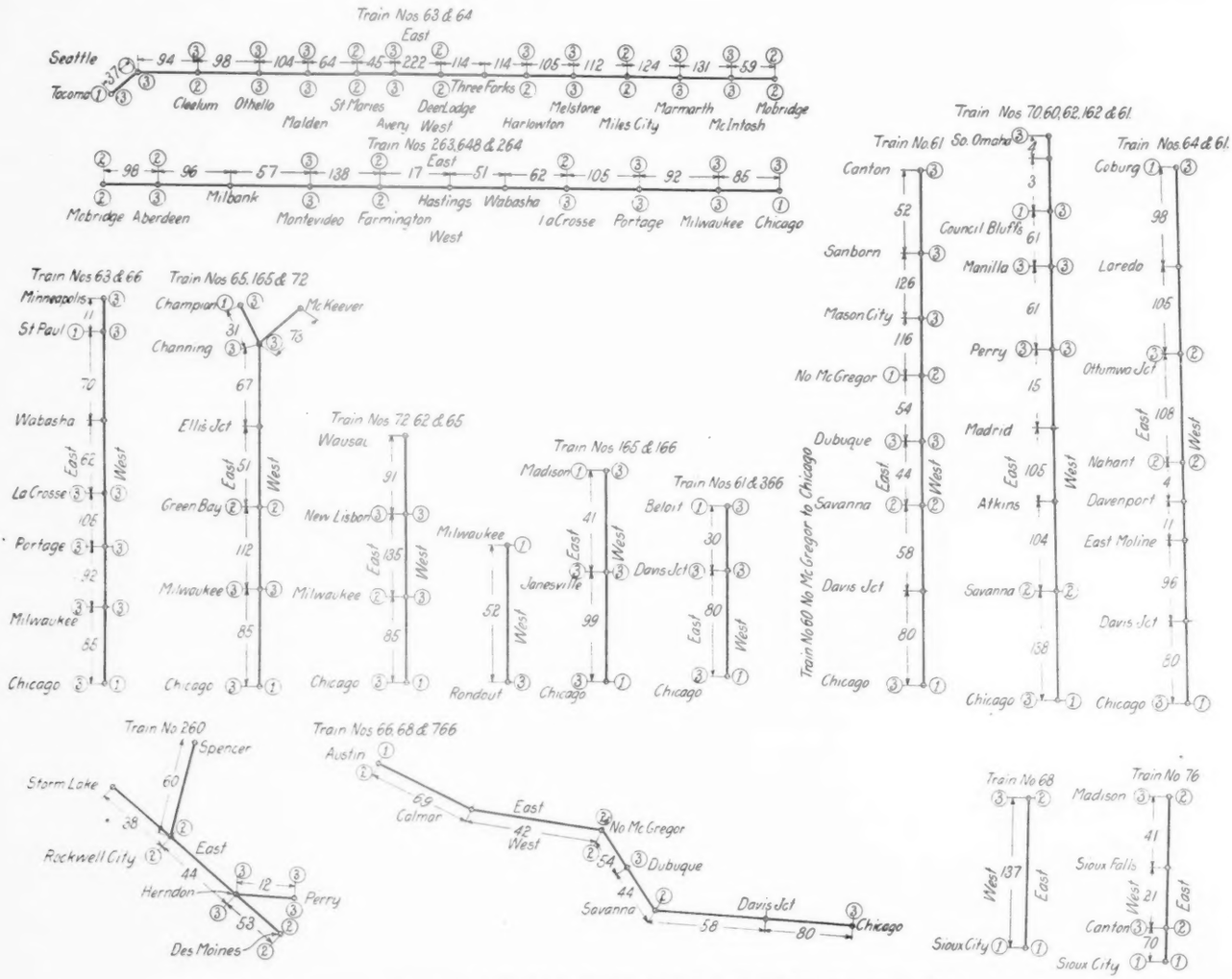
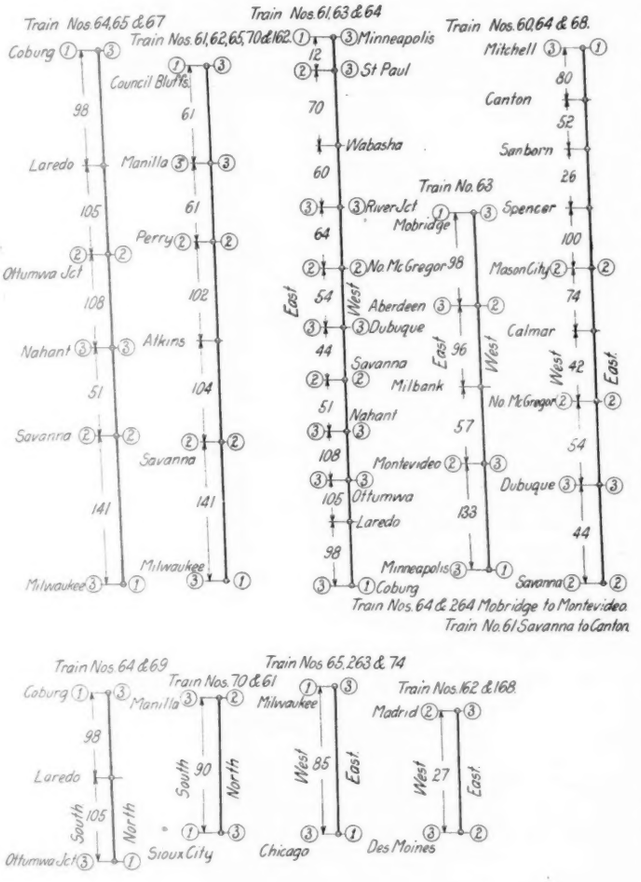


Diagram of Through Freight Trains Showing Provision for Inspection

necessity of providing proper doorway protection and blocking on house cars to overcome damage to the lading and injury at the doorway en route.

Granting that all of the previous requirements have been complied with, the car is accepted for train service to its destination and should proceed without serious difficulty. Primarily intermediate inspection is intended for the purpose of a protection on defects occurring through unfair service that impair the strength or serviceability of the car.

There would, naturally, seem to be little use for intermediate inspection, but when taken collectively the division of our railroad centers are so distributed that when the equipment reaches these intermediate terminals it has covered approximately from 150 to 300 miles, and the service demands an examination of the running gear, a re-examination and repair of all air brakes and care and attention to lubrication and packing, which as a rule is handled in about three to five minutes to a car.



METHOD TO BE FOLLOWED IN MAKING INITIAL INSPECTION.

The inspectors on the string as it reaches the receiving yard are two ground men, one roof man and two following-up men, and, where the interchange demands it, the same number starting from each end of the string, except the roof man. At this time inspection is made for all handling line defects under existing requirements, repairing all yard defects, such as nuts on box bolts, carry irons, column bolts, draft gear attachments, also brake connection bolts and cotters, brake shoes and keys, brake hangers and parts, and all connections of the hand-brake attachments. In many cases applying brake beams in the train yard is necessary in order to overcome switching any car to the shop track unless absolutely necessary. The finish of the string is then taken for switching and advanced to the receiving yard as a rule, where the air brake test, repairing and box packing is covered. The disposition of through business under such arrangements can be based on the interchange of 8,000 loads and 3,000 empties every 24 hours, with an average of one car out of ten as a cripple to the repair track. This indicates why a plea is made for better equipment at the initial point of loading to overcome serious delays that must be faced en route if such action is not taken, and which is kept constantly before us by the transportation department.

CLASS 2 INSPECTION.

Class No. 2 inspection, otherwise termed as that attention given cars passing from one grand division to another or having operated 300 to 500 miles without previously having had either No. 1 or No. 2 inspection.

This class of inspection contemplates suitable attention being given cars at certain definitely assigned divisional points and small originating and interchange stations. Under this classification wheels and axles should be given careful inspection. Brake shoes having a reddish color indicate that there has been a long application of the brakes which heat the wheels, and the latter should be carefully examined for cracks in the plates. Box lids should be opened and the condition of the lubrication and journals ascertained. Any bearing showing an indication of heating should receive the necessary attention.

Draft gear and couplers should be examined for the purpose of detecting defects that may have come into existence. Safety appliances must be repaired when found defective.

Brake beams and connections should be examined to see that they are up and in proper and safe condition. Brakes should be tested by the incoming engine making a 20-lb. reduction from a 70-lb. train line pressure and the brakes left set while the inspection is being made. The condition of truck sides and arch bars should also be observed and all missing nuts replaced and loose nuts tightened up.

Inspectors should so locate themselves in the yard that the train will pass them, when entering their respective yard, with a view of discovering loose and defective wheels and brake gear.

CLASS 3 INSPECTION.

Class No. 3 inspection, otherwise termed as that attention given equipment coming into a terminal and having recently received a No. 2 inspection at least within a distance of 300 miles and where engines are changed.

Inspectors should locate themselves in their respective yards so as to have the entire train pass them, observing closely and providing remedy for pounding wheels, brake beams and connections down or loose, hot bearings, defective draft attachments and related parts and violations of federal safety appliance requirements. After defects that were discovered on the train have been remedied, inspectors must proceed to make further inspection if time will permit.

INSPECTORS LOCATED AT ISOLATED STATIONS AND LARGE MANUFACTURING PLANTS.

There are many points on the system, especially at large terminals, such as the Dearing plant of the International Harvester Company at Chicago; Montgomery Ward & Co., Chicago; Solvay Coke Plant at Milwaukee; the Washburn-Crosby Co. at Minneapolis; packing plants at Sioux City, Omaha, St. Paul, Spokane; cereal mills at Cedar Rapids, etc., where high class competitive freight is loaded and received. Cars are made empty and unless carefully watched are apt to be reloaded out on our line in defective condition, due to defective running gear or improper body construction for loading with some other commodity, both opening an avenue to damage claims and excessive delay en route.

Adequate words could not be found in praise of car inspectors who do their whole duty at points like these, where

they are away from any immediate supervision, and can assist so greatly to see that only proper cars for any specified loading are allowed to be considered for outbound movement over the railroad, and where improper methods are followed in the use of or delivery of cars, either loaded or empty, that instant report is given so that proper precautions can be taken and the remedy applied. Cars being delivered loaded when found defective on account of no door protection being provided, in accordance with M. C. B. rules, or where cars marked for rough freight are delivered on request for merchandise cars or otherwise, or any other irregularities coming to notice day by day, should never be dropped until someone has seen to it that lax methods are avoided and stopped. In order to carry such a plan out it is always well for car inspectors to commence the day by going over all cars to note especially those fit for loading, marking out any which cannot satisfactorily be loaded, assigning the various grades of equipment to meet requirements, having in mind the territory on the system where they are to be made empty, and using good judgment in assuming that they must make a round trip at least so far as their physical condition is concerned, and also that they will be fit to carry a full return load of such commodities as originate in the territory from which they are to return. It is also well to remember when desirable to get cars to home connections full knowledge of the character and direction of the prevailing loading is necessary, so that proper loaded movement may result. In carrying out the actual work on cars handled, it is well to do the inside work first, then go over the draft gear, brakes, roof, safety appliances, trucks and packing in the order named. The remarks made herein also apply equally to one-man stations at outlying points along the railroad. There is always more or less shortage of equipment, especially the better grade of cars, and where such equipment is being misused through loading with rubish or otherwise, report must be made and the practice stopped.

(*To be continued.*)

BUREAU OF EXPLOSIVES PAMPHLETS

Two pamphlets, Nos. 20-I and 20-J, have recently been issued to wreck crews and car inspectors respectively by the Bureau of Explosives. Copies of the pamphlet follow and the full text of the regulations, from which the instructions are compiled, can be referred to readily by means of the reference to the Rules of the Bureau of Explosives at the end of each paragraph.

INSTRUCTIONS TO WORK CREWS.

Prevent fires at wrecks.—The most important point in handling wrecks is to prevent fires, especially if explosives or inflammables are involved. (1697, 1946.)

Remove explosives to a safe place.—All explosives, including broken packages, should be removed to a safe place, before beginning to clear a wreck. (1697.)

Prevent sparks in using tools, etc.—Every precaution must be used to prevent sparks when using tools, crane or locomotive to clear wreck. (1697.)

Saturate explosives remaining on ground.—Where probability of explosives remaining on the ground or in the wreck exists it should be saturated thoroughly with water. (1697.)

Handle dynamite with extra care.—Water on dynamites will not make it safe from shocks or blows, so that it is important that all such explosives be handled with extra care, even if wet. (1697.)

Handling fulminates in wrecks.—Mixing with wet earth makes all explosives safer to handle. In case fulminate has been scattered by a wreck, after the wreck has been cleared the wet surface of the ground should be removed and the area saturated with fuel or lubricating oil and then covered with fresh earth. (1697.)

Keep lighted lanterns away from inflammable freight.—It is assumed that wrecks always contain leaking and damaged packages and lighted lanterns or other flames should not be taken into or near cars containing inflammable freight. (1946.)

Ventilate all cars containing inflammable freight.—All cars containing inflammable freight must be opened for ventilation and all packages protected by red labels and all cylinders of compressed gases removed to a safe place. (1,-946.)

Remove yellow labeled substances.—All substances spilled from broken packages protected by yellow labels should be removed to a safe place. (1946.)

Cover inflammable liquids with dry earth.—All inflammable liquids spilled from broken packages or tank cars must be covered with dry earth before a lighted lantern, torch, or an engine is used in the vicinity. (1946.)

Handling spilled acids.—When acids are spilled in cars the floors should be covered with dry earth, swept clean and flushed with water. (1946.)

Use judgment to avoid fires.—Good judgment is necessary to avoid fires and useless sacrifice of property. (1951.)

Handle oil cars in daytime or use electric lights.—Dispense with all naked lights or fires possible when oil cars are leaking. Handle wrecked oil cars during daylight hours or use electric incandescent lights or electric flashlights. (1952.)

Keep lanterns on side from which wind is blowing.—When handling leaking tank cars having "inflammable" placards keep lanterns used for signalling on side from which wind is blowing and as high in air as possible, and keep lighted pipes, cigars and cigarettes away. The ash pan and firebox of a locomotive or steam derrick is also a source of danger. (1953.)

Drain leaking oil to prevent spreading.—Prevent the spread of oil by collecting it in any available vessels or draining it into a hole at a safe distance from track. Do not drain into sewers or streams of water. A stream of oil on the ground should be dammed and dry earth be thrown on the liquid as it collects. (1954.)

Do not drag wrecked tank cars.—Wrecked tank cars should be carefully jacked into position and should not be moved by dragging except as a last resort. All shocks and jars that might produce sparks or friction should be avoided. (1955.)

Handling leaking tank cars.—Do not transport leaking tank cars unnecessarily. Safety in short movements may be secured by attaching a vessel under small leaks. Cover tracks with fresh earth in rear to prevent fire overtaking car. Allow no smoking and keep engines away. If traffic is not obstructed contents of leaking tank cars should be transferred. (1956.)

Keep lights away from empty tank cars.—Keep lights away from empty or partially empty tank cars. (1957.)

Do not use water to quench oil fires.—When oil catches fire it should be smothered if possible by the use of earth, steam or wet blankets. Water will not quench an oil fire. (1958.)

Leaks at bottom outlet valves.—Leaks at unloading valves may possibly be stopped by removing the dome cover on top of tank and by moving the valve-rod handle in the dome back and forth a few times. (1959.)

Dome covers must not be removed while pressure exists.—Do not remove dome covers of tank cars containing inflammable liquids until satisfied, by lifting safety valve, that no pressure exists in tank. (1959.)

Keep trespassers away.—Guards should be placed to keep trespassers at a safe distance. (1955, 1956.)

SUGGESTIONS TO CAR INSPECTORS

Special inspection of cars necessary before loading explosives.—Certified cars to be used for explosives, must be carefully inspected inside and outside to see that the roof and sides have no loose boards, holes, or cracks, or unprotected decayed spots liable to hold sparks and start a fire; that the king bolts or draft bolts are properly protected, and that there are no uncovered iron or nails projecting from the floor or sides of the car which might injure packages of explosives; also that the floor is in good condition and has been cleanly swept before the car is loaded and that the journal boxes have been examined and that they are properly covered, packed and oiled, and that the air brakes and hand-brakes are in condition for service. (1661, 1662.)

Car certificates necessary.—Car certificates certifying to the proper condition of the car must be executed in triplicate by the car inspector. (1665.)

Inspection of explosives from connecting lines required.—Certified cars, containing explosives, when offered in interchange, must be carefully inspected by the receiving line and must not be forwarded until all violations have been corrected. Lading should also be inspected if practicable and it must be inspected when the car shows evidence of rough treatment. Only electric lights should be used when inspection is made after daylight hours. (1654.)

Company material not exempt.—Company material and supplies must be handled in accordance with the regulations. (1404, 1704.)

Inspect explosive cars frequently, and give notice if set out.—Cars containing explosives must be inspected at every opportunity to guard against hot boxes or other defects. When set out short of destination notice must be given, and all precautions taken to guard against accidents. (1690.)

Stenciling on tank cars necessary.—Tank cars must comply with M. C. B. specifications and must be stenciled to show such compliance. When not so stenciled, or if leaking, or any defects that would make leakage during transit probable, they must not be used for the transportation of any of the inflammable liquids. (1822-d.)

Inspection of loaded tank cars.—Loaded tank cars tendered for shipment must be inspected by the carrier to see that they are not leaking; tanks must be loaded with outlet valve caps off, and it is recommended that these caps be allowed to remain off until the car inspector passes on the car. Outlet valves must not permit more than a dropping of the liquid with the valve caps off. The inspector must also see that air and hand-brakes, journal boxes, trucks and safety appliances are in proper condition before accepting the car. (1822-e, f.)

Safety valves on tank cars.—Safety valves on tank cars used for the shipment of inflammable liquids whose flash-point is below 20 deg. F. must be set to operate at 25 lb. per sq. in., and the tank must be stenciled to show the pressure and date of test. (M. C. B. Rules; 1822-g, 1824-j.)

Dome placards.—The shipper must attach to the dome of all tank cars loaded with casing head or absorption gasoline, blended or unblended, three special white dome placards, one on each side of the dome and one on the dome cover. These cars also require four inflammable placards. (1824-k.)

Keep lights away from empty tank cars.—Lighted lanterns or other naked lights must not be used to examine the interior of empty tank cars. Only incandescent electric lights should be used for this examination. (1903-b.)

Dome covers and valve caps required on empty tank cars.—Empty tank cars should not be moved unless outlet valve caps and dome covers are securely placed in the proper position.

Inflammable liquids permitted in ordinary tank cars.—Gasoline, casing head gasoline, or any other inflammable (1903-c.)

liquids with flash points lower than 20 deg. F. may be shipped in ordinary tank cars that have been tested with cold-water pressure of 60 lb. per sq. in., and so stenciled, provided that the vapor tension of the liquid does not exceed 10 lb. per sq. in. (1824-j.)

Description of casing head products.—Casing head gasoline may be described as gasoline, casing head gasoline or casing head naptha when the vapor pressure does not exceed 10 lb. per sq. in., but when the vapor pressure exceeds 10 lb. per sq. in. it must be described as liquified petroleum gas. (1824-k.)

Liquified petroleum gas permitted in insulated tank cars.—Liquid petroleum gas of vapor pressure, not exceeding 15 lb. from April 1 to October 1, and 20 lb. from October 1 to April 1, when shipped in tank cars must be shipped in special insaluted tank cars approved by the M. C. B. Association. (1824-k.)

Guard against hot journals on inflammable cars.—Cars bearing "inflammable" placards and cars adjacent to them must be watched with extra care to discover hot journals, and every possible precaution taken to avoid igniting vapors when leakage is discovered. (1908.)

Stop leaking tank cars and keep lights away.—All unnecessary movement of tank cars discovered leaking in transit loaded with an inflammable or corrosive liquid must be stopped, and the unsafe condition corrected. Lanterns or other naked lights must be kept away from cars protected with inflammable placards and on the side from which the wind is blowing and as high in the air as possible. Electric lights should be used whenever practicable. Good judgment is necessary to avoid fires and useless sacrifice of property. (1909, 1951, 1953.)

Handle oil cars in daytime or use electric lights.—Naked lights or fires should not be used when oil cars are leaking. Wrecked oil cars should be handled during daylight hours, or electric incandescent lights, or portable electric flashlights used. (1952.)

Drain leaking oil to prevent spreading.—To prevent the spread of oil, it should be collected in any available vessels or drained into a hole at a safe distance from the track. It should not be drained into sewers or streams of water. A stream of oil on the ground should be dammed and dry earth thrown on the liquid as it collects. (1954.)

Do not drag wrecked tank cars.—Wrecked tank cars should be carefully jacked into position and should not be moved by dragging, except as a last resort, and all shocks and jars that might produce sparks or friction should be avoided. (1955.)

Handling leaking tank cars.—Leaking tank cars should not be moved unnecessarily. Safety in short movements may be secured by attaching a vessel under small leaks. Covering the tracks with fresh earth in rear will prevent the fire from overtaking the car. No smoking should be allowed and engine must be kept away. If traffic is not obstructed contents of leaking tank cars should be transferred. (1956.)

Keep lights away from empty tank cars.—Lights must be kept away from empty or partially empty tank cars or any care bearing inflammable placards. (1957, 1908-b.)

Do not use water to quench oil fires.—When oil catches fire it should be smothered if possible by the use of earth, steam or wet blankets, as water will not quench an oil fire. (1958.)

Leaks at bottom outlet valves.—Leaks at unloading valves may be stopped by removing the dome cover on top of the tank and by moving the valve-rod handle in the dome back and forth a few times. (1959.)

Release pressure before removing dome covers.—Dome covers of tank cars containing inflammable liquids should not be removed until no pressure exists in the tank, which should be ascertained by lifting safety valves. (1959.)

Stop "blowing" safety valves by cooling shell.—When the "blowing" of safety valves of a tank car is noted the car should be sprayed with water or any other possible means of cooling the shell of the tank should be used. (1912-d.)

Keep trespassers away.—Unauthorized persons must be kept away from explosives and other dangerous articles. (1643-b, 1871-d.)

Report violations.—Violations of the rules, such as defects of cars containing explosives, tank cars that do not comply with M. B. C. Rules or other requirements, etc., must be reported. (1434-a, 1715-a.)

Annual Report of the Bureau of Safety

Use of Hand Brakes on Heavy Grades Condemned; Automatic Stops and Train Pipe Connectors Tested

The report of the chief of the Bureau of Safety, which was recently issued is of particular interest this year, as it contains, in addition to the usual review of the safety appliance inspection work, important recommendations regarding air-brake maintenance and the operation of trains on heavy grades. The following is an abstract of the portions of the report dealing with these questions.

The table below affords opportunity for ready comparison of the results of inspections with previous years. It has been compiled from the principal figures for the fiscal years ended June 30, from 1915 to 1919, inclusive:

	1915	1916	1917	1918	1919
Freight cars inspected	1,000,210	908,566	1,100,104	1,059,913	1,023,942
Per cent defective...	4.77	3.72	3.64	3.92	3.7
Passenger cars inspected	33,427	27,220	29,456	25,732	23,712
Per cent defective....	2.85	1.82	0.85	0.56	0.39
Locomotives inspected.	38,784	31,721	37,199	33,806	30,707
Per cent defective....	4.06	3.66	2.69	2.18	1.84
Number of defects per 1,000 inspected	27.23	45.56	41.16	44.01	40.92

As shown by this summary, there was a decrease for the past year in the percentage of defects found on all classes of equipment inspected, namely, freight cars, passenger cars and locomotives; the number of defects per 1,000 cars and locomotives inspected is the lowest in the history of safety appliance inspection. For the past five years this percentage has been maintained at a low figure, but nevertheless the reports for the last fiscal year indicate a marked improvement in the general condition of safety appliance equipment.

An analysis of the figures, however, shows that of a total of 44,129 defects, comprising 244 distinct classes of defects, 22,275 were defects to visible parts of air brake apparatus, and of these 20,283 represent but 5 classes, viz.: air brake cut out, 7,124; cylinder and triple not cleaned within 12 months, 6,258; train pipe loose, 1,802; release rod missing, 3,258; and retaining pipe defective, 1,841. In other words, more than half of the total number of defects reported during the year were due to defective air brakes, 91 per cent of which were confined to five visible parts. It is apparent, therefore, that it is entirely practicable to effect a material improvement in the condition of safety appliance equipment. The remedy for this condition lies in more thorough inspection by the carriers themselves and prompt repair of defective equipment. Inasmuch as only a small percentage of cars and locomotives in service remains to be equipped in acocrdance with the safety appliance standards prescribed by the commission's order of March 13, 1911, the carriers will be in position to devote greater effort toward maintaining safety appliances in proper condition, and in future years still further decrease in the percentage of defects is confidently expected.

In the investigation of the condition of air brakes on trains as they left terminals after terminal or standing tests have been made by the commission's inspectors. Tests of 1,196 trains were made, aggregating 41,846 cars. In these trains there were but six non-air cars; there were 330 cars with their brakes cut out, and 1,947 on which the brakes did not apply; in the trains tested, the brakes were operative on an average of 93 per cent of the cars.

During the year, evidence of violations of the safety appliance laws by railroads operated under federal control has not been filed with United States district attorneys for prosecution, but such evidence has been furnished to the United States Railroad Administration to enable it to take corrective measures. In connection with the consolidation and unification of terminal facilities effected by the Railroad Administration, investigations conducted by this bureau have disclosed that in some instances proper inspection was not being given equipment in such terminals, and available repair facilities were not being sufficiently utilized to insure that cars having safety appliance defects would not be moved in violation of law. Several cases of this character were called to the attention of the Railroad Administration, and in each case, sometimes after conferences between representatives of this bureau and the railroad companies involved, proper corrective measures were taken so as to secure compliance with the requirements of law. The Railroad Administration has co-operated with this bureau to the fullest extent, to the end that safety appliance conditions be improved, and that the requirements of the safety appliance law be fully observed, and a marked increase during the year in the effectiveness of the administration of the safety appliance law has resulted.

Notwithstanding the requirement of law that trains must be controlled by power brakes without the use of hand brakes for that purpose, situations exist on several railroads in different parts of the country where trains are still controlled on mountain grades by means of hand brakes. Measures are being taken by this bureau, with the co-operation of the Railroad Administration, to bring about the discontinuance of this practice and to secure full compliance with the law. In some cases of this character, joint investigations have been conducted by this bureau and the railroad companies involved for the purpose of fully establishing what the present operating conditions are and what facilities are available for inspecting, testing, and repairing air-brake equipment. Demonstrations have then been conducted to show that it is both practicable and safe to control trains on these grades by means of power brakes, as required by law. These demonstrations consist of placing air-brake equipment on a number of trains in proper operating condition, and then operating these trains down the mountain grades in question, controlling the speed solely by the use of power brakes. In each case, a sufficient number of demonstrations of this character have been conducted to satisfy fully all concerned that operating practices conforming to the requirements of the law are feasible, and measures have then been taken by the Railroad Administration to place these practices in effect. Investigations and demonstrations of this character have already been conducted on the Baltimore & Ohio and

the Philadelphia & Reading, and investigations of operating practices on mountain grades of other railroads are now in progress. The investigations made have demonstrated that all that has been necessary was proper maintenance of air-brake equipment, as well as instruction and education of railroad employees in its proper use under the conditions existing on such grades.

These instances, together with the results of safety-appliance inspections during the past year, again direct attention to the fact that improvement in the condition of air-brake equipment and in air-brake operating conditions is one of the urgent demands of railroad service at the present time.

The order of the Commission of June 6, 1910, requires:

That on and after September 1, 1910, on all railroads used in interstate commerce, whenever, as required by the safety appliance act as amended March 2, 1903, any train is operated with power or train brakes, not less than 85 per cent of the cars of such train shall have their brakes used and operated by the engineer of the locomotive drawing such train, and all power brake cars in every such train which are associated together with the 85 per cent shall have their brakes so used and operated.

The minimum percentage requirement established by this order is generally understood and recognized, and it is an infrequent occurrence that a train is hauled from a terminal having less than 85 per cent of the cars equipped with power brakes in operative condition. However, in addition to the minimum percentage requirement specified, the order also reiterates the provision of law that all power-brake cars in a train which are associated together with the specified minimum percentage shall have their brakes used and operated. Railroad companies have paid comparatively little attention to this maximum requirement of the law and order, and the belief is widespread and general that if a train has the prescribed minimum percentage of power-brake cars with air brakes in operation, the terms of the law are fully complied with. It is common practice at the present time for trains to leave terminals having some cars with inoperative brakes, or having brakes cut out, notwithstanding the fact that facilities are available at such terminals for making repairs or replacements necessary to place all power-brake equipment in proper operative condition.

Strict enforcement of the provision that "all power-brake cars in every such train which are associated together with the 85 per cent shall have their brakes so used and operated," as applied to trains leaving terminals or other points where facilities for making repairs are available, would result in 100 per cent operative power brakes in practically all trains leaving such points. The adoption of this practice would inevitably result in general and material improvement in air-brake conditions, as careful and thorough air-brake tests at terminals would be required as well as that more prompt attention be given necessary air-brake repairs. It would also result in reducing the number of violations of the minimum percentage requirement, for the reason that frequently trains now leave terminals with barely 85 per cent of the cars having power brakes in operative condition, and if the brake equipment on additional cars becomes defective en route, or if cars with defective brakes are picked up, or if cars with good brakes are set out, the train then has less than the required 85 per cent.

The adoption of this policy would go far toward meeting the complaint referred to in the last annual report, which is still frequently heard, that air-brake maintenance is neglected on roads where braking conditions are less severe than on roads having steep mountain grades, thereby imposing an excessive burden on the air-brake inspection and repair forces of the latter roads.

As stated in the annual report of this bureau for last year, notwithstanding the adverse decision of the Circuit Court of Appeals for the Fourth Circuit in the Chesapeake & Ohio case, it is believed that a proper interpretation of the law requires that the air brakes of all cars in every train which have been equipped with power brakes, as distinguished from non-air cars, and which are associated with cars having operative power brakes, must be in operative condition and must be used by the engineer of the locomotive drawing the train. The ground upon which the minimum percentage was prescribed was that there were numerous cars in service which had not been equipped with power brakes, and provision should be made for continuing them in service until they could be equipped. It is clearly evident that the maximum requirement of the law and the Commission's order is a progressive one, making it obligatory upon the carriers to use air brakes in an increasing ratio until all cars are equipped; and the provisions are mandatory that when all cars in train are equipped with power brakes, all such brakes must be used by the engineman of the locomotive hauling the train.

In addition to terminal tests of trains made up for departure, more general adoption of the practice of conducting air brake tests on trains when arriving at terminals is also advocated. Incoming tests of this character disclose the condition of air-brake equipment in time to permit of necessary repairs and adjustments being made without delaying trains made up and ready for departure, as well as eliminating switching for the purpose of setting out cars with defective brakes.

The air-brake provision of the law has again been passed upon by the Supreme Court of the United States in the case of Louisville & Jeffersonville Bridge Co. *v.* United States, involving the movement of transfer trains from one yard to another, crossing city streets at grade and using the main-line track for a distance of at least 2,600 feet, without the specified minimum percentage of power brakes being in use. In this case the court stated that it would be difficult to imagine a movement in which the control of the cars by train brakes would be more necessary, notwithstanding that the street crossings were protected by gates and the main-line movements were watched over by a yardmaster from an elevated tower. It was also stated that the absolute duty to comply with the law is not excused by carefulness to avoid the danger which the appliances prescribed were intended to guard against, nor by the adoption of what might be considered equivalents of the requirements of the act.

This same provision has also been interpreted by the Circuit Court of Appeals for the Fifth Circuit in two cases involving the movement of tranfser trains in and about the city of Galveston for several miles, crossing main-line tracks of several railroads and streets at grade, and for parts of the distance over main-line track as well as a network of tracks comprising the city yards, without the specified minimum percentage of power brakes being in use. It was held that the movements in question were not switching operations, but train operations to which the law applies. It was also held that the fact that there were switching operations before the movements were completed did not have the effect of making the entire movements such as do not come within the prohibition of the statute.

INVESTIGATION OF SAFETY DEVICES.

During the year plans of 80 devices were submitted for consideration; 74 devices were examined and opinions thereon transmitted to the proprietors. Of the number examined, 57 were so impracticable or crude that they were considered practically worthless; seven were devices which were not intended primarily to promote safety in railway operation, and 10 possessed elements of merit which warranted further development or practical tests to prove their utility. In addition, revised plans of 15 devices which had been previously examined were submitted for further consideration, and all of these plans were examined and reported upon; four of these latter devices were commended to the extent

of warranting further development or trials under service conditions. Among the devices upon which favorable reports were made, there were eight automatic train-control devices, five brake devices or attachments and one railroad tie.

During the year tests were conducted of the automatic train-control system submitted by the National Safety Appliance Company, San Francisco, Cal. This device is of the magnetic induction type employing permanent magnets in both track and locomotive equipment, as well as an electromagnet on the track for nullifying or neutralizing, when desired, the effect of the permanent track magnet. Tests were made on the Western Pacific and the Southern Pacific Railroads from March to June, 1919, and a report upon this device was transmitted to Congress by the Commission under date of June 30, 1919, this report being printed as House Document No. 139, Sixty-sixth Congress first session. The following conclusion is stated in that report:

While as a whole the tests made are not considered conclusive, it has been demonstrated that, with the exception of one of the locomotive-control valves used in the tests, the locomotive apparatus, so far as could be determined, operated as intended, and whenever actuated by the track-magnet impulse it accomplished the functions for which it was designed; further, that the transmission of a magnetic impulse from a permanent magnet installed on the track to locomotive apparatus designed to be controlled and actuated thereby is both practical and feasible. The fundamental principles upon which this system is based have therefore been demonstrated to be sound and practicable, but the available working limits, as well as the reliability of the transmission and control of the actuating impulse, remain to be fully established. For these purposes further development work, as well as more extended trials under practical service conditions, is necessary.

Tests have also been conducted of the automatic train-pipe connector submitted by the American Connector Company, Cleveland, Ohio. This device is in use on the Copper Range and tests were made in July and August. A report upon this device was transmitted to Congress by the commission. The conclusion stated in this report is that the use of this automatic connector on the Copper Range materially reduces the hazards to which trainmen are subjected as it almost entirely eliminates the necessity for men to go between the cars of connector-equipped trains. The device tested possessed some features which were not fully applicable to general railroad operating conditions, but the results of the tests and its use on that road warrant its further development for the purpose of more fully meeting the requirements of an automatic train-pipe connector for general railroad service.

COMPARATIVE TESTS OF REFRIGERATOR CARS

Temperature Readings in Actual Service on Cars Equipped with Overhead and End Ice Bunkers

THE object of this test was to investigate the comparative refrigerating performance of a car equipped with overhead ice tanks and one equipped with collapsible end ice tanks. Both cars were pre-iced and loaded with Tokay grapes and were handled under standard refrigeration from Lodi, Cal., to Chicago, Ill.

The equipment used in the test consisted of Santa Fe refrigerator car SFRD 12646 and Chicago Great Western refrigerator car 30000. SFRD 12646, Class U, was built in the winter of 1917-18, and is equipped with Santa Fe standard collapsible bulkheads (Bohn Syphon) without floor racks. Car GGW 30000 was built in the fall of 1915, and in the spring of 1919 it was reinsulated to make the insulation two inches thick, the same thickness as SFRD 12646. During the summer of 1919 the ice tanks, baffle and drains of car CWG 30000 were reconstructed for experimental purposes. This car was taken for the test before final permanent construction of the hatches, tanks and baffle had been made in order that the test could be conducted this season. The results of the test as regards temperature, air circulation and refrigeration would not be affected by this temporary installation. Car GGW 30000 is equipped with six overhead basket ice tanks of the Moore type and with floor racks.

The following table shows the principal dimensions of the two cars under test:

	CGW 30000	SFRD 12646
Loading capacity	60,000	60,000
Outside length	40 ft.	41 ft. 3 in.
Inside dimensions—		
Length	37 ft. 10⅝ in.	33 ft. 2¼ in.
Width	8 ft. 2 in.	8 ft. 2¾ in.
Height floor to ceiling	7 ft. 8⅛ in.	7 ft. 3 in.
Height racks to ceiling	7 ft. 3⅜ in.	.....
Height racks to ice tank	5 ft. 11⅛ in.	.....

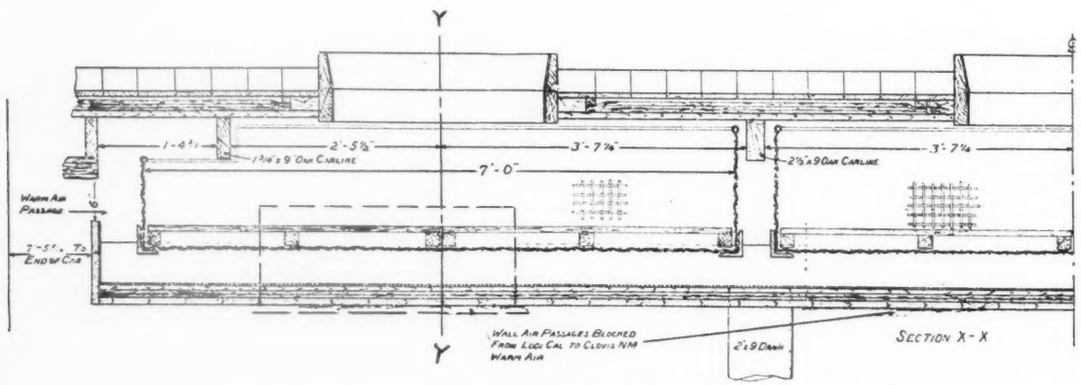


Fig. 1. Longitudinal Section Through Ice Tanks of C. G. W.-30,000

Ice tank—		
Kind	Overhead	Basket End Collapsible
Ice capacity	6,300	10,500
Bulkheads	4¾ in.	Bohn Syphon
Insulation, thickness	False ends 2 in.	2 in.

TABLE I—COMPARISON OF TEMPERATURES, IDENTICAL LOCATIONS, CARS, GRAPES UNDER REFRIGERATION, SFRD 12646 VS. CGW 30000

Location	Therm. No. 3		Therm. No. 4		Therm. No. 5		Therm. No. 6		Therm. No. 7		Therm. No. 8		Therm. No. 9		Therm. No. 11		Therm. No. 12		Therm. No. 1		Therm. No. 10		Therm. No. 2	
	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646	CGW 30000	SFRD 12646
Lodi, Cal.	58.7	61.3	56.2	54.2	59.5	60.2	59.0	59.3	59.0	59.0	56.4	53.7	57.1	58.6	56.6	60.8	53.4	58.7	57.8	56.4	57.8	49.3	60.0	60.6	55.3	72.6
Stockton, Cal.	53.4	59.8	54.4	48.0	56.3	59.5	55.7	56.8	57.5	66.2	54.2	42.6	57.0	58.7	54.1	53.4	56.4	57.8	55.8	48.2	52.3	45.7	54.8	54.9	46.7	59.2
Riverbank, Cal.	50.3	58.6	53.0	46.2	55.8	58.2	53.2	55.7	55.6	57.1	52.7	41.9	57.7	50.8	50.7	48.3	52.3	49.6	52.8	47.5	50.0	43.9	53.9	52.9	46.0	56.4
Calwa, Cal.	47.7	56.3	51.4	44.4	54.8	57.0	51.5	55.6	54.6	54.1	50.0	38.2	54.7	47.5	46.3	48.4	45.8	45.8	48.4	45.8	45.8	43.3	52.2	53.4	44.6	53.8
Bakersfield, Cal.	46.1	54.2	49.8	42.8	53.5	55.2	51.5	54.9	53.0	51.7	47.6	37.5	52.2	45.5	44.7	46.5	44.1	48.0	45.4	43.7	48.0	42.2	50.2	48.9	39.6	57.1
Barstow, Cal.	44.3	51.1	47.7	41.6	52.4	52.7	49.3	51.9	51.2	45.4	45.4	36.8	50.6	42.9	43.3	44.8	44.5	45.4	44.8	41.8	45.5	41.2	49.3	49.5	40.4	53.2
Needles, Cal.	43.1	49.0	45.9	41.2	50.5	50.7	47.5	50.4	49.4	46.1	46.1	36.7	50.2	42.5	44.2	43.0	44.4	44.9	44.9	41.8	44.9	41.2	49.2	48.8	36.0	51.5
Needles, Cal.	42.8	48.3	45.3	40.5	50.1	50.5	47.1	50.8	49.3	46.0	46.6	36.6	49.9	42.3	44.0	42.9	44.2	44.8	43.7	41.5	43.7	41.5	48.9	48.4	36.6	50.8
Needles, Cal.	42.6	48.0	45.2	40.5	49.7	50.3	47.1	50.5	49.2	46.0	45.6	36.5	49.2	41.8	43.6	42.6	43.8	44.3	43.8	43.0	44.3	42.6	48.5	47.3	37.9	49.0
Kingman, Ariz.	42.0	47.2	44.6	40.3	49.9	49.8	46.8	48.4	48.4	45.6	45.4	36.5	48.7	41.6	43.3	42.5	43.6	44.0	43.6	41.4	44.0	42.5	48.2	47.1	38.2	48.7
Cherokee, Ariz.	41.8	46.9	44.5	40.3	49.3	49.0	46.6	48.0	48.0	45.4	45.4	36.7	48.7	41.6	43.3	42.5	43.5	43.7	43.1	41.1	43.7	41.4	48.1	47.6	38.3	50.1
Seligman, Ariz.	41.5	46.6	44.2	40.2	48.5	48.9	46.4	48.4	47.9	45.4	45.4	36.7	48.5	41.7	43.3	42.4	43.6	43.6	43.1	41.2	43.6	41.2	48.1	47.7	39.3	50.5
Ash Fork, Ariz.	41.7	46.6	44.1	40.2	48.2	48.6	46.2	48.2	47.8	45.3	45.3	36.7	48.2	41.7	43.3	42.1	44.5	43.4	42.9	41.2	43.4	41.2	48.0	47.0	36.3	49.6
Williams, Ariz.	41.6	46.3	44.0	40.1	48.0	48.4	46.1	48.1	47.6	45.1	45.1	36.5	48.2	41.8	43.3	42.1	44.5	43.6	43.1	41.2	43.6	41.2	48.0	47.0	37.3	47.0
Winslow, Ariz.	41.6	45.9	43.9	40.2	47.9	48.0	45.7	48.8	47.0	45.0	45.0	36.5	47.8	41.8	43.1	42.0	43.1	43.0	42.9	41.0	42.9	41.0	47.4	45.7	36.4	45.6
Adamana, Ariz.	40.6	45.2	43.5	39.8	47.5	47.3	46.3	47.5	45.7	43.8	44.4	36.4	46.9	42.4	41.9	42.0	42.4	42.6	41.8	40.5	41.9	40.5	46.4	44.9	39.0	46.1
Gallup, N. M.	40.0	44.5	43.1	39.5	46.9	46.3	44.9	46.7	45.1	43.1	43.1	35.8	45.8	39.8	41.5	40.9	41.4	41.6	41.2	39.7	41.4	39.7	45.4	43.8	36.3	45.2
Belen, N. M.	39.4	43.7	42.3	39.2	45.8	44.9	44.1	44.7	45.9	44.0	42.5	35.6	44.8	39.4	40.5	40.5	40.9	41.0	40.4	39.8	40.4	39.8	44.4	42.5	35.9	43.3
Vaughn, N. M.	38.9	42.7	41.8	38.8	44.9	45.4	43.3	43.7	44.0	44.0	42.3	36.1	44.5	39.2	40.4	40.9	40.9	40.8	40.3	40.3	44.5	40.3	45.0	44.5	36.9	47.4
Glovis, N. M.	39.0	42.6	41.5	38.8	44.9	45.6	43.1	43.7	45.4	44.0	42.3	36.2	44.8	38.9	40.3	40.5	41.0	40.8	40.2	39.2	40.8	40.2	44.7	44.1	35.1	46.4
Amarillo, Tex.	39.1	43.1	40.9	39.2	44.3	44.9	42.7	42.7	45.0	44.3	41.9	36.2	44.8	38.8	40.2	40.9	40.8	40.9	40.0	39.1	40.9	40.1	44.3	44.0	35.8	46.1
Canadian, Tex.	38.9	43.2	40.6	39.4	44.0	44.8	42.6	35.8	44.7	44.2	41.8	36.6	44.8	38.6	40.2	40.9	40.5	40.7	40.2	39.2	40.9	40.2	45.3	47.3	35.2	51.2
Amarillo, Okla.	39.3	43.6	40.6	39.5	43.9	45.4	42.5	35.4	44.6	41.8	41.8	36.3	39.0	45.5	40.0	41.0	39.0	40.7	41.0	40.6	41.0	40.6	44.9	45.7	36.6	40.3
Waynoka, Okla.	38.7	44.3	40.1	39.8	43.6	45.6	42.8	35.2	44.1	45.4	41.5	36.2	38.2	45.7	40.0	41.0	39.6	39.4	40.8	40.7	41.5	41.5	44.7	44.5	37.3	47.7
Wellington, Kan.	38.0	43.9	40.2	39.7	43.4	45.4	42.1	35.4	44.0	44.9	41.5	35.6	38.8	45.4	40.0	41.5	39.6	39.4	40.7	40.7	40.3	40.7	44.3	44.1	37.9	46.9
Wellington, Kan.	38.0	43.6	40.0	39.5	43.2	45.0	42.0	35.1	43.6	44.5	41.3	35.9	38.8	45.1	39.8	40.9	39.2	40.4	40.0	41.1	43.0	42.1	42.1	42.1	35.9	43.6
Emporia, Kan.	37.9	42.8	40.0	39.1	42.7	44.2	41.9	34.3	43.5	43.2	41.3	36.0	43.9	38.6	39.6	40.6	39.2	40.3	39.3	40.9	42.5	42.9	42.9	42.9	33.9	44.6
Argentine, Kan.	37.7	42.6	39.7	38.7	42.3	43.5	41.5	34.3	43.0	40.8	40.6	35.7	38.5	43.8	39.2	40.2	39.2	40.1	39.1	40.1	42.7	42.7	43.7	43.7	33.9	45.2
Lexington Jct., Mo.	37.4	42.3	39.5	38.6	42.3	43.7	41.2	34.2	42.7	42.5	40.6	35.4	38.3	43.9	39.2	40.1	39.1	39.5	38.1	39.8	40.1	38.2	41.2	40.4	34.6	40.8
Shopton, Iowa	37.0	41.7	39.2	37.7	42.0	42.9	41.0	34.2	42.3	42.0	40.0	34.8	37.8	42.8	38.1	39.0	37.9	39.6	38.0	38.0	40.8	41.4	40.8	41.4	33.6	42.7
Chillicothe, Ill.	36.4	41.6	38.8	37.3	41.7	42.4	39.8	34.0	41.8	42.0	39.4	34.5	37.4	42.3	37.7	39.0	37.9	37.6	39.3	37.5	40.5	40.1	41.4	44.5	33.5	46.9
Corwith Yards, Chicago	36.0	40.7	38.2	37.2	41.2	42.0	39.4	33.9	41.4	41.7	39.2	34.2	37.1	42.2	37.4	38.7	37.6	38.4	37.5	37.9	40.1	41.1	42.1	43.4	35.9	44.6
Average	41.6	48.2	43.9	40.7	47.7	48.4	44.1	35.3	46.8	47.6	44.7	37.2	41.9	48.1	42.9	43.0	43.3	44.2	42.6	41.6	47.0	46.9	38.1	49.1		

CAR CGW 30000

Location

Bulb No.

1. Temperature of air at top of floor rack, center of car, 12th stack, center row.
2. Temperature of air coming out of cold air passage in overhead baffle, center of car, 12th stack.
6. Fruit temperature top box grapes, 1st stack next end of car, center row.
4. Fruit temperature of bottom box grapes, 8th stack, center row.
5. Fruit temperature top box grapes, 4th stack, center row.
6. Fruit temperature top box praces, 1st stack next end of car, center row.
7. Fruit temperature, top box grapes, 1st stack next end car, center row.
8. Fruit temperature bottom box grapes, 4th stack, center row.
9. Fruit temperature top box grapes, 8th stack, center row.
10. Air temperature in warm air passage at end of baffle, center row.
11. Fruit temperature bottom box grapes, 12th stack, center row.
12. Fruit temperature 5th box grapes above floor, 12th stack, center row.

CAR SFRD 12646

Location

Bulb No.

1. Temperature of air at floor, center of car, 11th stack, center row.
2. Temperature of air below ceiling, geometric center of car.
3. Fruit temperature top box grapes, 11th stack, center row
4. Fruit temperature bottom box grapes, 7th stack, center row
5. Fruit temperature top box grapes, 4th stack, center row.
6. Fruit temperature bottom box grapes, 1st stack, next bulkhead, center row.
7. Fruit temperature top box grapes, 1st stack next bulkhead, center row.
8. Fruit temperature bottom box grapes, 4th stack, center row.
9. Fruit temperature top box grapes, 7th stack, center row.
10. Air temperature at top of bulkhead opening, warm air returning to ice tank.
11. Fruit temperature bottom box grapes, 11th stack, center row.
12. Fruit temperature 5th box grapes above floor, 11th stack, center row.

APPARATUS.

The temperature observations taken in the cars throughout the test were obtained by means of Leeds & Northrup resistance type electrical thermometers obtained from the U. S. Department of Agriculture, Bureau of Markets, and were calibrated, previous to installing in the test cars, by means of an ice bath. The locations of the bulbs for recording the temperature of the lading are given in the footnotes to Table I. A balanced indicator was used for reading the car temperature from the outside, so that it was not necessary to open the doors en route to obtain the temperatures of the fruit.

The amount of ice used in each car during the test was

Fig. 2. Cross Section Through Overhead Tank, C. G. W.-30,000

estimated from full cakes of artificial ice in order to more accurately determine the amount. Outside temperatures throughout the test were obtained by means of mercury thermometers, read as often as practicable. The resistance bulbs were located in the head end of each car only. No temperature readings were taken in the rear half of the test cars.

METHOD OF TESTING.

After the cars were selected at Calwa, Cal., they were forwarded dry to Stockton, Cal. At Stockton CGW 30000 had

the six warm air passages at the side walls blocked, as shown in Fig. 1. These passages were blocked to see if greater uniformity of temperatures could be obtained than if left open. The passages remained blocked from the time the cars were loaded at Lodi, Cal., up to Clovis, N. M., where they were all opened, thus permitting the air to circulate up the side wall passages into the ice tanks as well as through the air passage at the end of the baffle.

The cars were pre-iced at Stockton at 6 p. m. October 7 at the Santa Fe ice plant, where 10,500 lb. of ice were placed in the bunkers of SFRD 12646 and 4,275 lb. of ice in the tanks of CGW 30000. The small amount of ice furnished CGW 30000 as compared to the total ice tank capacity (6,300 lb.) was due to the poor manner in which this car was iced at that point. No salt was used in either car at any time during the test. After initial icing both cars were forwarded to the warehouse of the T. H. Peppers Company at Lodi, Cal., via the Central California Traction Company, where they were loaded on October 8.

The loading of the cars commenced at 8 a. m. and was completed at 2:30 p. m. The ends of both test cars in which the electrical thermometers were located were loaded first.

Temperature readings by means of mercury thermometers during the loading period showed that the grapes were at a temperature of 59 deg. F. in both cars.

SFRD 12646 was loaded with 1,050 standard crates of grapes, weight 29,400 lb., 10 layers high, 5 rows wide and 11 stacks long in the end in which the electrical thermometers were located, and 10 stacks long in the opposite end. CGW 30000 was loaded with 1,072 standard crates of grapes, weight 30,016 lb., 9 layers high, 5 rows wide and 12 stacks long in the end in which the thermometers were located, and 11 and 12 stacks long in the opposite end. In both test cars the regulation center bracing for grape cars was used to prevent the load shifting in transit.

Both cars were sealed at 2:30 p. m., at which time initial temperature readings of the electrical thermometers were taken. Both test cars were billed to Chicago, Ill., under standard refrigeration; routed Lodi to Stockton, Central California Traction Company, Stockton to destination, Atchison, Topeka & Santa Fe.

The temperatures of both cars, as well as the total amount of ice furnished and the outside temperatures, are shown in Table I. The following table gives the amounts of ice furnished at each icing station en route, as well as the total amounts furnished:

		CGW 30000		SFRD 12646	
Location	Date	Amount, Lb.	Total Amount, Lb.	Amount, Lb.	Total Amount, Lb.
Stockton, Cal.....	Oct. 7, 1919	4,275	4,275	10,500	10,500
Stockton, Cal.....	Oct. 8, 1919	1,710	5,985	1,995	13,495
Bakersfield, Cal. ..	Oct. 9, 1919	2,550	8,535	1,950	14,445
Needles, Cal.	Oct. 10, 1919	1,300	9,835	1,750	16,195
Winslow, Ariz. ...	Oct. 12, 1919	1,100	10,935	1,100	17,295
Belen, N. M.....	Oct. 13, 1919	400	11,335	700	17,995
Clovis, N. M.....	Oct. 13, 1919	800	12,135	550	18,545
Waynoka, Okla. ..	Oct. 14, 1919	1,250	13,385	1,000	19,545
Argentine, Kans. ..	Oct. 16, 1919	2,000	15,385	1,700	21,245
Corwith Yards, Chicago, Ill.	Oct. 18, 1919	500	15,885	1,100	22,345

The cars left Lodi, Cal., at 3:15 p. m. October 8 and arrived at Corwith Yds., Chicago, at 1:15 a. m. October 18, thus making the total time for the 2,470-mile trip 9 days, 9 hrs. and 55 min., or an average speed of 11.0 miles per hour.

After the cars arrived at Corwith Yards on the morning of October 18 no further temperature observations were taken. Cars were moved to the Twenty-first street yards of the Santa Fe, where the electrical thermometer equipment was removed. The cars were held at the yards for consignee's order and for inspection of the fruit by the consignee's inspectors, Santa Fe inspectors and inspectors of the Inspection Service, U. S. Department of Agriculture, Bureau of Markets.

GENERAL RESULTS.

As shown by the table above, the total amount of ice furnished SFRD 12646 was 22,345 lb. and for CGW 30000 was 15,885 lb., a difference of 6,420 lb., or 28.8 per cent in favor of CGW 30000. Both cars had the ice tanks filled to the same capacity at the final reicing at Corwith, as at the initial icing at Stockton. The total amount of ice melted in each is the difference between the total amount of ice furnished in transit and the initial icing. This gives 11,845 lb. melted in SFRD 12646 and 11,610 lb. melted in CGW 30000, or an ice rate of 47.2 lb. per hr. for SFRD 12646 and 46.3 lb. per hr. for GGW 30000.

In the end ice tank car it was necessary to keep the bunk-

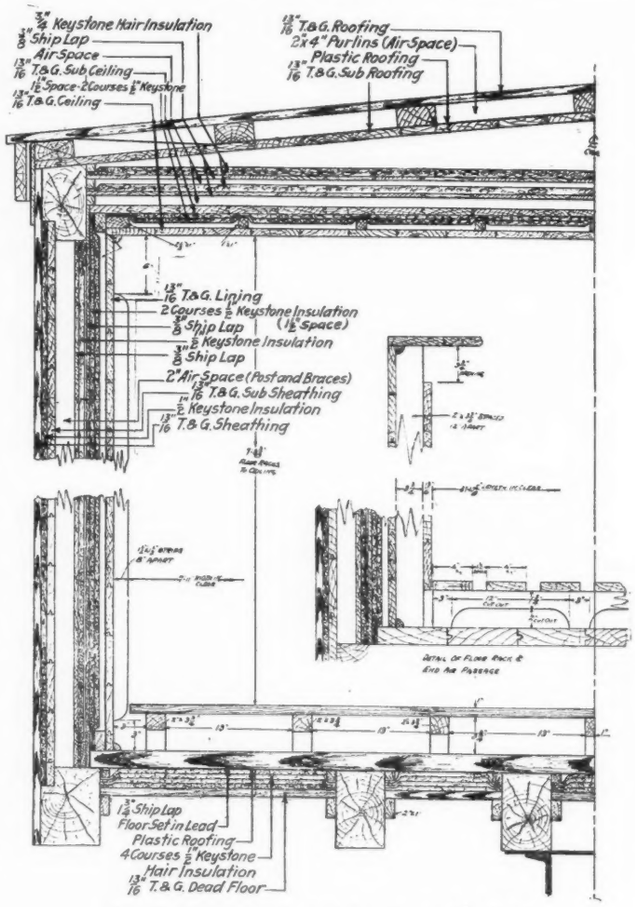


Fig. 3. Cross Section of Car C. G. W.-30,000

ers full of ice in order to secure proper refrigeration, as the ice in the lower portion of the bunkers afforded very little, if any, effective refrigeration; the car equipped with overhead ice tanks had all of the ice located so as to create refrigeration, thus making it possible to carry less ice and yet obtain the same temperature.

The chart in Fig. 5 is plotted from the average of fruit temperatures taken at the bottom and top layers of fruit. Bulbs number 3, 5, 7 and 9 were averaged to show the fruit temperatures of the top layer; bulbs number 4, 6, 8 and 11 were used for averaging fruit temperatures in the bottom layer. This chart and the data in Table I, giving the temperature comparisons in both cars, show that at times there was no difference in the temperature of the fruit in the bottom and top layers of car CGW 30000; that the maximum difference was 1.4 deg. F., and the average difference was 0.4 deg. F.

The minimum difference in the temperatures of the fruit in the bottom and top layers of SFRD 12646 was 5.6 deg.

F. The maximum difference was 14.3 deg. F., and the average difference was 8.6 deg. F. The maximum difference occurred at the commencement of the test while the temperature of the fruit was being reduced.

The marked uniformity in the temperature of the fruit in

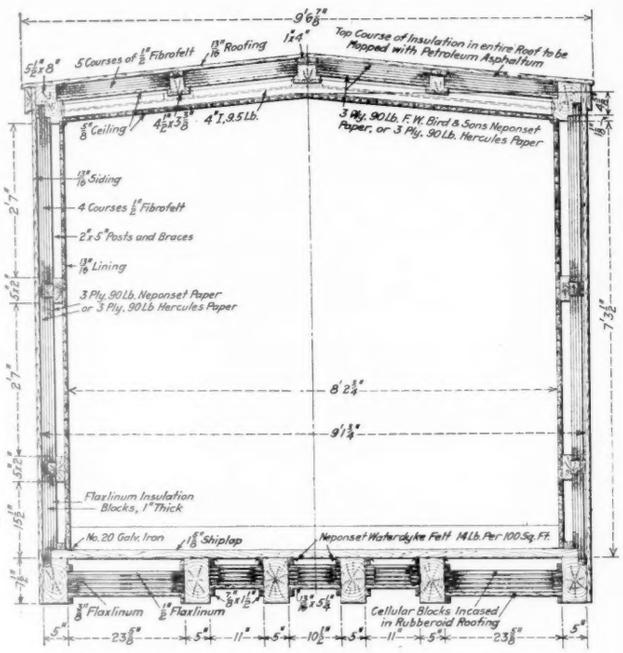

Top Course of Insulation in entire Roof to be Mopped with Petroleum Asphaltum
5 Courses of 1" Fibrofelt
Roofing
Ceiling
4"I. 9.5 Lb.
3 Ply. 90 Lb. F.W. Bird & Sons Neponset Paper, or 3 Ply. 90 Lb. Hercules Paper
Siding
4 Courses 1" Fibrofelt
2"x 5" Posts and Braces
Lining
3 Ply. 90 Lb. Neponset Paper or 3 Ply. 90 Lb. Hercules Paper
Flaxlinum Insulation Blocks, 1" Thick
No. 20 Galv. Iron
Shiplap
Neponset Waterdyke Felt 14 Lb. Per 100 Sq. Ft.
Flaxlinum
Flaxlinum
Cellular Blocks Incased in Rubberoid Roofing

Fig. 4. Cross Section of Car A. T. & S. F.-12,646

car CGW 30000 demonstrated a uniform circulation of refrigerated air throughout the entire load. The temperature of bulb No. 2 in SFRD 12646, located six inches below the ceiling at the geometric center of the car, fluctuated considerably and was affected more by the outside air temperatures than any other thermometer, as shown in Table I. This fluctuation was due to the heat passing through the roof of the car, affecting the air furthest from the ice tanks. Due to the location of the ice in the car equipped with the overhead refrigeration system, any heat passing through the roof of the car must have been prevented from reaching the load by its immediate absorption by the ice in the overhead tanks.

At the time the fruit was loaded its temperature was 59 deg. F. At the time the car was sealed the average temperature of the fruit in the top layer of CGW 30000 was 58.0 deg. F. and in the bottom layer 56.6 deg. F. The temperature in the top layer of SFRD 12646 was 59.8 deg. F. and in the bottom layer 52.0 deg. F. This shows that the fruit in the bottom layer of the latter car had cooled 7.0 deg. F.; while the fruit in the top layer had increased 0.8 deg., that the fruit in the top and bottom layers of CGW 30000 was cooled 1.0 deg. and 2.4 deg., respectively. At destination the average fruit temperature of the top layer in CGW 30000 was 38.9 deg. F. and the bottom layer 38.5 deg. F., a difference of 0.4 deg. In SFRD 12646 the average temperature at destination in the top layer was 41.6 deg. F. and in the bottom layer 36.0 deg. F., a difference of 5.6 deg.

The top layer of fruit throughout the test averaged 47.7 deg. F. for SFRD 12646 and 44.7 deg. F. for CGW 30000, or 3.0 deg. lower in car CGW 30000 than SFRD 12646. The temperature at the lower layer in SFRD 12646 is affected by the cold air coming directly off the ice, which accounts for the lower temperatures of this layer.

The bottom layer of fruit throughout the test averaged 44.3 deg. F. for CGW 30000 and 39.1 deg. F. in SFRD 12646, or 5.2 deg. lower in SFRD 12646 than CGW 30000. No effect was noticed in the temperatures throughout the load in CGW 30000 when the side wall air passages were either blocked or left open.

ICING IN TRANSIT.

In constructing CGW 30000 with the improved overhead icing system several changes were made in order to secure maximum refrigeration and uniform circulation throughout the car. The car had previously been equipped with six hatches; these were not altered to instal the six overhead ice tanks. The hatches were not originally designed to be used

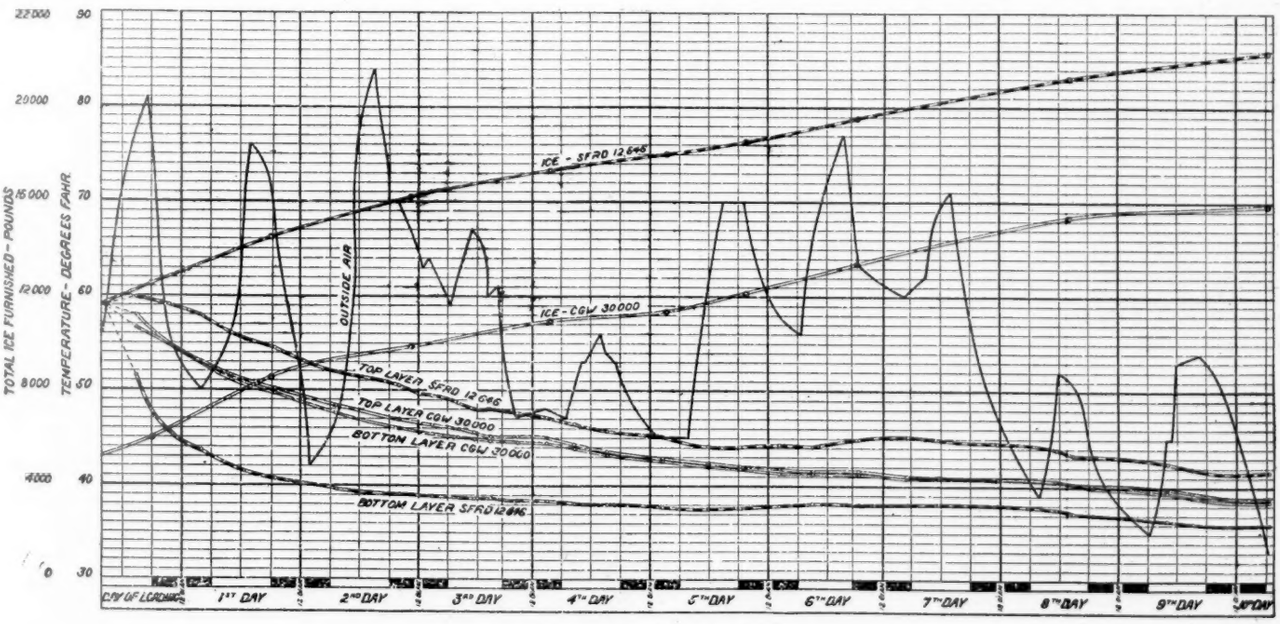


Fig. 5. Range of Temperature and Ice Furnished During Refrigeration Test

with the ice tanks, as finally installed in the car, and difficulty was encountered during the test in icing this car; considerable more time was required to properly ice this car than the other test car equipped with end ice tanks.

The objectional feature in icing this car can be overcome

by using tanks setting transversely and lengthening the hatchways, so that each tank can be iced from two hatchways. The construction and insulation of CGW 30000 with the overhead ice, tanks are shown in Figues 1, 2 and 3.

INSPECTION AT CHICAGO.

Three separate inspections of the grapes in the two test cars were made at the yards of the Santa Fe by consignee's inspectors, by Santa Fe inspectors and by government inspectors of the Inspection Service, Bureau of Markets, U. S. Department of Agriculture.

The consignee's inspection report showed that the grapes in SFRD 12646 were decayed and moulded much more than those in GGW 30000, the difference in the quality of the grapes in the two cars being great enough to cause the consignee to unload those in SFRD 12646 at Chicago and to divert CGW 30000 on to New York market.

The Santa Fe's inspection report showed "slight decay and mould in CGW 30000, some decay and mould in SFRD 12646, four crates in top layer near doorway slightly wet, caused apparently by leak from roof." These statements infer that the grapes in CGW 30000 were in better condition than those in SFRD 12646 and corresponds to the condition found by consignee's inspectors.

The reports from the Inspection Service of the Bureau of Markets, U. S. Department of Agriculture, are as follows:

SFRD 12646—Stock well packed, highly colored, and presents attractive appearance; a few mouldy berries scattered through top half of load, as noted above (top 5 layers crates, balance of load practically no decay). Impossible to inspect entire car without unloading; certificate restricted to one stack crates next bracing, each end of car. Temperature top of door 46 degrees F., bottom 42 degrees F.

CGW 30000—Decay in this car slightly in excess of that in car SFRD 12646. Stock well packed, highly colored, a few scattered mouldy berries, showing very good appearance. impossible to inspect entire car without unloading; certificate restricted to one stack crates next bracing, each end of car. A few mouldy berries scattered throughout most crates, also many berries showing slight mould at stems. Temperature at top of door 42 degrees F., bottom 40 degrees F.

It does not seem that the consignee would have diverted CGW 30000 to New York and unoladed SFRD 12646 if the inspection as shown by government inspectors had been true. The temperatures shown by the government inspection report at the door was 4 deg. lower at the top in CGW 30000 than in SFRD 12646 and 2 deg. lower at the floor of the car, notwithstanding their claim of there being less decay in SFRD 12646.

The four crates, "slightly wet," referred to in the Santa Fe inspection report, resulted from condensed moisture dripping from four baffle supporting bolts which were not properly protected.

CONCLUSIONS.

1. Car CGW 30000, equipped with overhead ice tanks, was furnished with 28.8 per cent less ice than car SFRD 12646, equipped with end ice tanks.

2. At times there was no difference in the temperature of the fruit in the top and bottom layers of car CGW 30000; the maximum temperature difference was 1.4 deg.; the average temperature difference was 0.4 deg.

3. The minimum temperature difference of the fruit in the top and bottom layers of car SFRD 12646 was 5.6 deg.; the maximum temperature difference was 14.3 deg.; the average temperature difference was 8.6 deg.

4. The fruit in the top layer of CGW 30000 throughout the test averaged 44.7 deg. F. and that in SFRD 12646 averaged 47.7 deg. F., or 3.0 deg. higher than in the same layer of CGW 30000.

5. The fruit in the bottom layer of CGW 3000 throughout the test averaged 44.3 deg. F. and that in SFRD 12646 averaged 39.1 deg. F., or 5.2 deg. lower than in the same layer of CGW 30000.

6. The temperatures in test car CGW 30000 showed that the air circulation was practically uniform throughout the entire load, giving substantially uniform temperatures in all the creates of grapes.

7. The temperature in test car SFRD 12646 showed that the air circulation was not uniform throughout the load, causing an extremely wide variation of temperatures in the grapes in the bottom and top layers.

8. The time required for icing CGW 30000 was considerably greater than SFRD 12646, but by changing the design of the ice tanks and hatches practically the same time would be required for icing both cars.

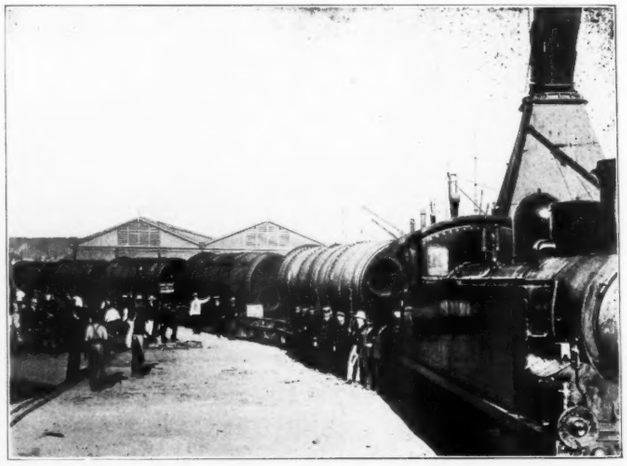
9. The condition of the grapes in CGW 30000 was much better than in SFRD 12646, the percentage of decayed grapes running much higher in SFRD 12646 than in CGW 30000.

10. Consignee's inspection reports on the condition of the grapes in the two test cars upon arrival in Chicago warranted them forwarding CGW 30000 on to New York market and in their unloading those in SFRD 12646 on the Chicago market.

11. The inspection report on the condition of the grapes in the test cars upon arrival in Chicago, made by the Inspection Service of the Bureau of Markets, U. S. Department of Agriculture, was superficial, since only one stack of crates in each end of car was inspected, and was contradictory to the other reports, both of which showed less decay in CGW 30000 than in SFRD 12646.

12. On the whole, the test showed the performance of CGW 30000 to be superior to SFRD 12646, since it used less ice, gave a substantially uniform temperature throughout the entire car and carried the load in better condition than the other car.

This test was made by G. J. Congdon, supervisor fuel and refrigeration, Chicago Great Western, and witnessed by Lester W. Collins, mechanical engineer, Refrigerator Heater & Ventilator Car Company, St. Paul, Minn. The test was made possible through the co-operation of the shippers, T. H. Peppers Co.; consignee, Crutchfield, Woolfolk & Clore; the officials and employees of the Santa Fe Refrigerator Despatch Co., and Santa Fe Railroad. The Bureau of Markets, U. S. Department of Agriculture, Washington, D. C., loaned sufficient electrical thermometer equipment for conducting the test.



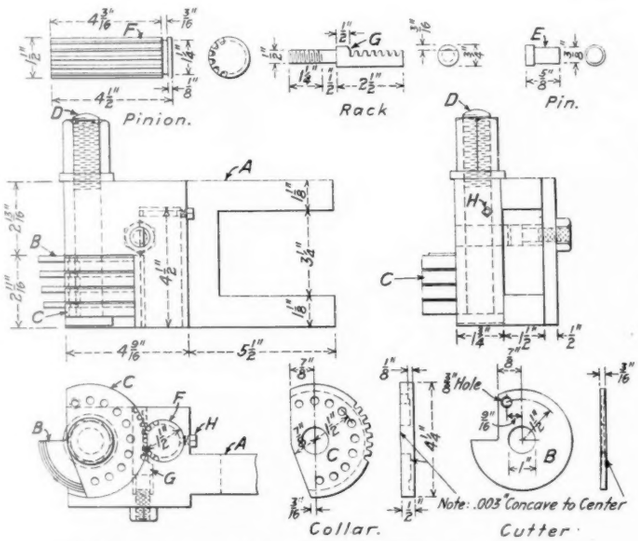
Scene on the South African Government Railways

SHOP PRACTICE

GANG CUTTERS FOR PISTON RINGS

In the operation of a railroad repair shop there are many ways in which economies can be effected, and in no other way can more be done in this respect than in the many small jobs on machines.

A rapid and economical means of cutting piston rings on a boring mill has been devised in the Canadian Pacific shops and is illustrated in the accompanying drawings. The device consists of a holder *A*, in which are inserted four cutters *B*, each having an individual collar *C*, all secured in the holder by the bolt or pin *D*. The cutter *B* is provided with a 3/8-in. hole so located as to coincide with any one of a series of similar holes through the collar *C*, by means of which the cutter can be secured in any position that may be desired, by inserting the pin *E* in the holes. The collars are provided with teeth which mesh with similar teeth on the pinion *F*. Adjustment of the cutters may be obtained



Details and Assembly of Piston Ring Gang Cutters

by a movement of the rack *G*, which also has teeth meshing with the pinion *F*. After the cutters are adjusted to the position the set screw *H* is tightened, thus securing the cutters in the desired position.

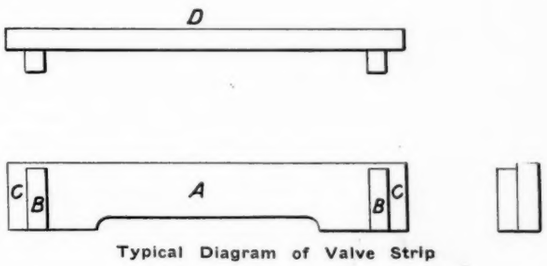
As will be seen from the drawings, the cutting edges of the cutters *B* may easily be ground without any decrease in the diameter of the cutter and, consequently with no change in the thickness and spacing of the cutting edges. The particular cutters illustrated were designed for piston rings 3/8 in. thick, but the idea may be adapted to any size desired, or if conditions make it necessary, the number of rings cut at one operation may be increased or decreased as may be advisable.

The use of this device has permitted a considerable economy in the Canadian Pacific shops. Its advantages are obvious, as the high cost of labor at the present time makes it necessary to utilize machines and men to their full capacity.

MACHINING VALVE PACKING STRIPS

BY A. W. C.

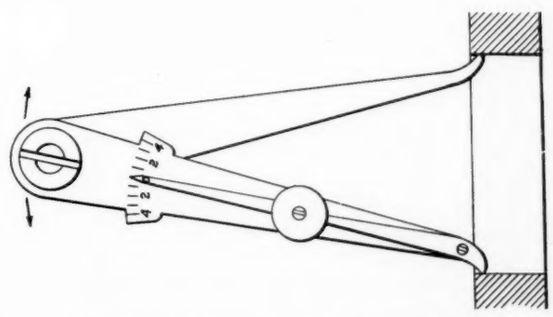
The proper machining and fitting of the packing strips used in balanced slide valves is of great importance, as any leakage of steam by these strips is a total waste. New men when given the short strips to shape are often puzzled as to the best way to machine them, as they are difficult to get at to caliper. Usually the surface *A* between the lugs is finished first on a shaper, surfaces *B* and *C* being shaped at the same time and care being taken that surfaces *C* are finished with



Typical Diagram of Valve Strip

the tool set at the same depth as when finishing surface *A*. The strip is then laid with surface *A* or surfaces *B* on a parallel and machined on surface *D*. The strips are calipered at either or both ends with more or less satisfactory results. The necessity of having surfaces *C* finished exactly in line with surface *A* is here seen, otherwise incorrect calipering results. When cutting surface *D* it is necessary to take a cut over far enough to get the calipers on, and it is this cutting and calipering that is the time consuming operation, especially when a large number of strips are machined.

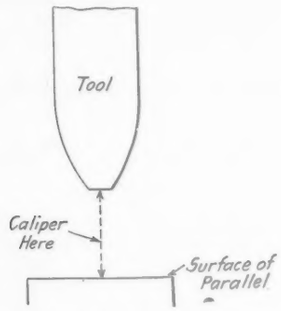
The following is a method of machining packing strips that has been used with excellent result. The indicating



Type of Caliper Used for Gaging Thickness

caliper or gage illustrated is first lightly clamped to a tool shank by a small clamp and used as an indicator would be to determine if the parallel is really parallel with the shaper ram's travel. Any discrepancies are remedied by tissue paper liners. The parallel used is of a length that will allow the strip to be placed with surface *A* on it (about seven inches long), this surface having been finished first. No particular

care is given surfaces *B* or *C*, which eliminates one time-consuming feature. The valve groove is then measured with the calipers by tapping the solid leg until the indicator registers on any graduation, the graduation being noted. A broad-nosed tool is held in the tool post, the tool having a small flat ground on it, as illustrated. The caliper is placed between the parallel and tool and the tool is adjusted vertically until the indicator shows that the tool is a distance from the parallel equal to the width of the groove in the valve; that is, the indicator points to the same graduation as it did when in the groove. The vertical micrometer collar is now set at zero and a roughing cut taken over the strip which is held on the parallel by a pair of shaper hold-downs. A finishing cut is next taken after feeding the tool down a few thousandths. Once having decided how many thousandths to run the tool down, it is an easy matter to fit all strips uniformly, as each strip can be made any desired number of thousandths smaller than the grooves. The filing and spotting of the strips is thus reduced to a minimum, which saves 25 to 50 per cent on the machining time.



Method of Setting Tool

PRESSURES FOR MOUNTING WHEELS AND APPLYING CRANK PINS

BY JAMES PARTINGTON
Estimating Engineer, American Locomotive Company

In locomotive and car construction, it is the general practice to use hydraulic pressure for mounting wheel centers on axles, applying crank pins, etc. The different operations involved may be classified as follows:

1. Mounting cast iron driving wheel centers.
2. Mounting cast steel driving wheel centers.
3. Applying crank pins in cast iron driving wheel centers.
4. Applying crank pins in cast steel driving wheel centers.
5. Mounting cast iron truck wheel centers.
6. Mounting cast steel or wrought steel truck wheel centers.
7. Mounting cast iron chilled tread truck wheels.
8. Mounting cast steel or rolled steel truck wheels.

Very little information seems to be available in printed form to indicate the pressures which should be used for these different operations and the following table showing the practice of the American Locomotive Company has been found by long experience to give satisfactory results. The basis of this table as worked out for operations, (1) and (3), was the commonly accepted formula for cast iron centers which calls for 10 tons pressure per inch of diameter of the shaft. These pressures have been consistently adhered to for cast iron driving wheel centers, having been amplified only to the extent of permitting a minimum pressure of 10 per cent less and fixing 20 per cent excess pressure as the allowable maximum.

For operations (5) and (7), the pressures required have been reduced somewhat because the requirements for truck wheels are not as exacting as for driving wheels and the greater pressures approach too closely to the point at which the smaller diameter axles may bend. The reason for this reduction is readily apparent when it is considered that the relative stiffness of axles is expressed in terms of the cube of the diameter and the table of pressures is made in terms of the first power of the diameter.

In the table covering truck wheel mounting pressures, it will be noted that the figures followed by an asterisk are the Master Mechanics and Master Car Builders' Standards of 1916 as are also the preferred pressures used for cast iron and cast steel wheelcenters. For operations (2) and (4) covering cast steel driving wheel centers, having wheel fits, or crank pin fits 6½ in. in diameter or over, the preferred mounting pressures have been increased to 16 tons per inch of diameter with a minimum of 10 per cent less and a maximum allowable excess of 25 per cent above the preferred pressure. These increased pressures have been adopted for steel centers on account of the different characteristics of the material; *i. e.*, a somewhat lower coefficient of friction and a greater uniformity in the strength of the metal to resist fracture.

For operations (2) and (4) with wheel fits and crank pin fits under 6½ in. in diameter, the preferred mounting pressures are 13 tons per inch of diameter, and for the very small sizes, which are never used in ordinary locomotive practice, 11 tons per inch of diameter. For operations (6) and (8) the mounting pressures have been reduced for the same reasons as outlined for operations (5) and (7).

It will be noted that the mounting pressures for cast steel or wrought steel truck wheel centers, and cast steel or rolled steel trucks wheels, also agree with the Master Mechanics and Master Car Builders Standards of 1916. Locomotive trailing truck wheels over 36 in. in diameter are placed in the same classification as driving wheels in determining the mounting pressure. Crank pins and wheels applied at the pressures given in this table have given uniformly satisfactory service for a long period of years.

TABLE OF MOUNTING PRESSURES USED BY THE AMERICAN LOCOMOTIVE COMPANY

	MOUNTING PRESSURES IN TONS										
	Axles and crank pins in: Driving wheels, trailing wheels (over 36 in. in diam.)						Axles in: Engine truck wheels, trailing truck wheels (36 in. in diam. and under), tender truck wheels				
	Cast steel centers			Cast iron centers			3.78¾ dollars for Cast steel or solid w. steel			£.. 22.3 Cast iron chilled tread	
Seat diam. in in.	Min.	Prefd.	Max.	Min.	Prefd.	Max.	Wheel seat diam. in in.	Cast steel or wrought steel centers. Min.	Max.	Cast iron centers. Min.	Max.
2½	25	28	35	22	25	30	4	35	50	25	35
3	30	33	41	27	30	36	4½	40	55	30	40
3½	35	39	49	31	35	42	5	45	60	30	45
4	47	52	65	36	40	48	5⅛*	45*	60*	30*	45*
4½	53	59	74	40	45	54	5½	50	70	35	50
5	58	65	81	45	50	60	5¾*	50*	70	35	50*
5½	65	72	90	49	55	66	6	55	75	35	55
6	70	78	98	54	60	72	6½*	60*	80*	40*	60*
6½	94	104	130	58	65	78	7*	65*	85*	45*	65*
7	101	112	140	63	70	84	7½	70	95	50	70
7½	108	120	150	67	75	90	7⅝*	70*	95*	50*	70*
8	115	128	160	72	80	96	8	70	95	50	70
8½	122	136	170	76	85	102	8½	75	100	55	75
9	130	144	180	81	90	108	9	80	105	...	...
9½	137	152	190	85	95	114	9½	85	115	...	...
10	144	160	200	90	100	120	...	...	...	...	...
10½	151	168	210	94	105	126	...	...	...	...	...
11	158	176	220	99	110	132	...	...	...	...	...
11½	166	184	230	...	...	...	...	...	...	...	...
12	173	192	240	...	...	...	...	...	...	...	...
12½	180	200	250	...	...	...	...	...	...	...	...
13	187	208	260	...	...	...	...	...	...	...	...
13½	194	216	270	...	...	...	...	...	...	...	...

*M. M. and M. C. B. standards of 1916.

EUROPEAN EQUIPMENT.—According to the British Ministry of Transport, 6 per cent of the cars are out of service awaiting repairs. The percentages of some other countries are: France, 15; Italy, 18; and Austria, 35. The percentage of locomotives awaiting repairs is 21 in Great Britain; in France, 22; Italy, 27; and Austria, 37.—*The Engineer.*

RAILWAY SHOP CONDITIONS IN ENGLAND

High Cost of Labor and Decreased Output Is Building up Excessive Costs—Great Need for Improved Devices and Modern Machinery

By ROBERT E. THAYER
European Editor of the Railway Mechanical Engineer

AS A DIRECT HERITAGE of the war England has had, in common with almost every other nation, to face a very great increase in the cost of labor. Wages have not only increased but output has been decreased through the adoption of the eight-hour day and a general decline in the morale of the workmen. The English railways and particularly the railway shops have felt these changed conditions keenly, more keenly perhaps than any other industry and surely more keenly than the railway shops of America on account of the fact that before the war English railways never had much worry over the cost nor the quantity or quality of labor.

With plenty of cheap and well trained workmen before the war, there was not the incentive for English railroad shop managements to adopt more modern systems of shop operation or improved shop appliances and labor saving machinery that existed in America where wages were high and skilled workmen were scarce. Furthermore, with cheap, well skilled labor and more or less unrestricted finances there has been every incentive for the railway mechanical officers in Great Britain to produce equipment that from the view point of workmanship was a work of art. Under the present conditions, however, this perfection in construction involves a high manufacturing cost that is being felt. In addition to this there has not been the demand for improved and new shop equipment to handle new equipment of increased weight and dimensions as in America, on account of the fact that the physical characteristics of the English roads, such as structural clearances and permissable weight on rail, have not permitted these roads to extend to the same extent as in the States. The equipment of 30 or 40 years ago is now not out of place on English roads. As a matter of fact there is still in operation much of the equipment built at that time. The English railway mechanical officer has therefore devoted the greater part of his time and energy on refinements in construction and design rather than on the increased size of his equipment or improved shop equipment.

Butt riveted boilers, concave journals and bronze driving boxes are some of the unusual features of construction found on British locomotives.

The situation as it exists today presents an entirely different story. Labor is no longer cheap; output has been curtailed; materials have increased in price, and heavy deficits in net revenue present a demand for economy. The cost of maintenance and renewals of English rolling stock (including locomotives) has increased from £13,257,617 in 1913, to £14,156,816 for the first six months of 1919, or an increase of 213 per cent. The cost of locomotive running expenses has increased from £17,130,661 in 1913, to £18,168,295 for the first six months of 1919, or an increase of 212 per cent. If the railways of Great Britain are to meet expenses they either must increase their rates or operate more economically. There are great opportunities for savings to be made in the mechanical departments but investment will be necessary in shop equipment, and new and improved methods both in design, construction and repairing equipment will be necessary.

Locomotive building practices in Great Britain involve the use of more expensive materials and a higher grade of workmanship than is demanded in the United States. The English locomotives have copper fireboxes, copper dry pipe and copper stay bolts, (about 2½ tons). In numerous instances these engines will be provided with copper tubes although with the present high cost of copper, steel tubes are more generally used. In addition to this many roads have a standard practice of using bronze driving boxes (about 550 lb. each) instead of cast steel driving boxes with the crown brass as is common in the States. This greatly increases the overhead cost of the locomotive and adds a greater carrying charge which naturally affects the net returns, particularly with copper at £105 and bronze at £180 per ton. There are but few locomotives that are provided with wedges in the pedestals, the designer preferring to provide an accurate sliding fit between the driving box and the pedestals in preference to bothering with shoes and wedges. This requires expensive fitting. The motion work in a number of cases is fitted on a testing table before it is placed on the locomotive. One road follows the practice of fitting its cylinders, crosshead guides, guide yoke, etc., on a dummy engine frame in order to ensure proper alinement, before they are placed on the locomotive.

The boiler practice is also carried to a higher degree of refinement than is used in the States. Many roads have what is called a parallel boiler, that is the different courses are butt riveted with a welt strip shrunk on. The barrel sheets are not laid out for the rivet holes on the flat but are assembled and each rivet hole is drilled in a huge machine called a boiler barrel drilling machine. Most English roads use inside cylinders with cranked axles of both the solid and built-up type. Furthermore it is not uncommon to find the rear driving axles with concave journals and driving boxes fitted to these journals although it should be said that no new engines are built in this manner. It is a standard practice in flue works on some roads to stretch the flues after they have been removed from the boiler under repair to make up for the length cut off in removing the flues. In some cases tubes are stretched nine inches. This applies to both copper and steel tubes. In other shops safe ends are brazed on to the tubes, the safe end being milled and the tube taper-turned for fitting and a joint made with a copper ferrule. All spring work is done by hand, the methods of the past being perpetuated.

The railway shops themselves in many cases are old, representing a gradual development only in size. Railway shop practice, due as mentioned above to the fact that the cost of labor was so cheap before the war, has not progressed. Where American roads are now endeavoring to get away from as much fitting and bench work as possible, not only due to its excessive cost but on account of the fact that it is difficult to obtain first class machinists for this work, one finds in the English railway shop a large area of the shop space given over to this bench work.

It is all of these things which contribute to the excessive

cost of locomotive construction and repairs and it is here than the greatest field for economy is presented. The Railway Gazette, one of our London contemporaries, recently commented on the bids offered by British and American locomotive manufacturers on an order for the Egyptian State Railways. These figures show that the British builders quoted a price from 76 to 81 per cent higher than the successful American bidder. This will illustrate how the new conditions in the labor and material markets have affected British practices and give an indication of the necessity for more up-to-date shops in Great Britain.

The English roads generally build their own power and the British locomotive manufacturers deal more particularly with export business. As a result of this the English railroad will have under the jurisdiction of its mechanical department a more or less complete locomotive manufacturing plant. Taking one case in particular, that of the Crewe shops of the London & North Western, it might be stated that that plant needs only a coal mine and an iron mine located on its premises to make it self-supporting. The spreading out of locomotive building plants in this manner has also tended to increase the cost of locomotive manufacture, particularly on account of the fact that most of these plants are badly equipped.

As regards car building a similar policy is followed, that is, very few roads go outside for their new freight or passenger cars. A fine passenger car is built by the English railroads which in common with locomotives involves much labor. In contrast to this, however, are the freight cars which are nothing more or less than ordinary wagons mounted on axles and provided with an ordinary lever hand brake. The general size of these wagons is either of 10 or 12-ton capacity. They are simplicity itself in construction and due to the large number required to handle the business make a profitable manufacturing proposition for the individual railroads. But a very small number of these wagons are equipped with automatic brakes. They are principally of wooden construction, although due to the high price of timber a number of steel underframe cars are being built. The wheels are of a built-up design made in the car manufacturing plants. The shop cost for a pair of 38-in. wheels mounted on an axle having 9-in. by 4-in. journals is approximately $125. The English roads have considered the use of cast-iron wheels but not having been sufficiently impressed with their safety, they still adhere to their own design of built-up wheel. The cost of these freight cars has increased greatly. Before the war a 12-ton open top car could be built by the railways for about $400, but the present cost has been recently quoted as about $1,000 in railway shops and about $1,500 in car building plants. The car shops are more or less in the same category as the locomotive shops. There are some well laid out and well equipped shops on certain roads. Perhaps that of the Midland at Derby is the best in England. This shop contains many modern and improved woodworking tools, most of which were obtained from America.

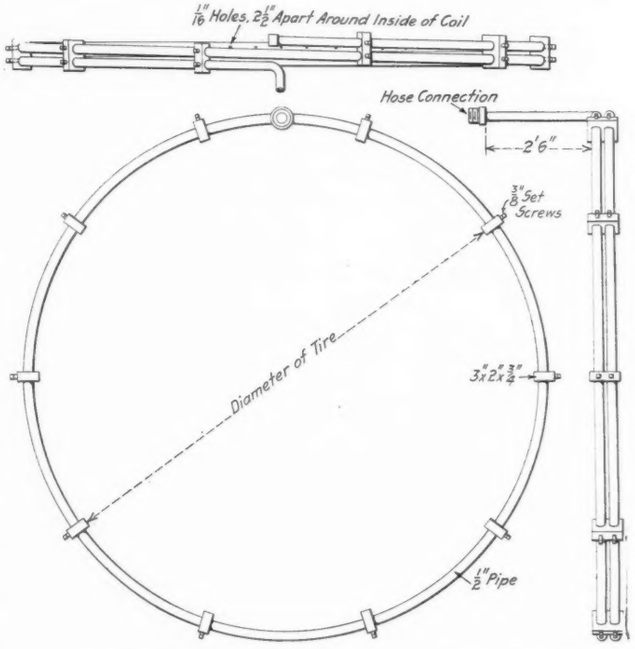
This brief review of railway shop conditions in England indicates a wonderful possibility for improved railway shop appliances and machinery. Something must be done to reduce the excessive cost of manufacture and repairs, and with labor and material conditions so vitally different from what they were before the war, the railway shop managements are seeking a way out of the difficulty. It may be argued that with the English railroads in the hands of the government and with a standard net return guaranteed the shareholders, the English railroads will not be as anxious to make immediate improvements to their plants which would involve heavy expenditures. Government control will not run much more than 18 months hence and at the end of that time if the roads go back to their private owners economies must be anticipated to the greatest possible extent. On the other hand, if the government retains control of the roads either through nationalization or otherwise there will still be the necessity for improvements. It is not believed, however, that the railways will defer taking action in such matters until they pass out of the hands of the government and in fact serious thought is being given to the modernization of railway shops by many of the more important of the British railroads.

LOCOMOTIVE TIRE HEATER

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

When the railway shops were required to use crude oil or kerosene in place of gasoline in tire heaters considerable difficulty was experienced. Many experiments were made and a number of different designs worked out more or less satisfactorily, but at times there was trouble in getting the heaters to start promptly. Time and oil were wasted and sometimes the shop was filled with gas and smoke from the oil, which, together with the flames, was not only annoying but dangerous.

To overcome these difficulties the tire heater illustrated was designed by N. Carlson, pit foreman of the Duluth &



Tire Heater Which Vaporizes the Oil Before Burning

Iron Range at Two Harbors, Minn. The heater consists of a piece of ½-in. iron pipe, bent in a continuous double helical coil, with spacing blocks to keep the pipes in the right position and the right distance from the tire. It is important that the latter distance so adjusted that the hottest point of the flame is at the tire. The first section of the coil has no small holes in it and merely acts as the preheater. The second section, which goes next to the tire flange, is provided with a continuous row of 1/16-in. holes, drilled 2½ in. apart. The usual form of oil container and vaporizer is then connected to the shop air line and to the tire heater by a hose connection.

This form of tire heater has proved to be both easy to start and economical in the use of oil. It is possible to obtain a good blue flame with kerosene, and by making coils of suitable diameters any size of tire can be heated in a satisfactory manner.

How Jim Dugan Finally Won A "Real" Job

Everything Went Wrong at Crossover Until He Took a Fresh Hold. First Entry in the Prize Story Contest

BY ANDREW J. FENTON

DRESSED in hip rubber boots, heavy mackinaw, an ear-lap cap pulled down over his ears and with thick gloves on his hands in addition to his regular clothing, Jim Dugan started through the deep snow for the roundhouse at Crossover.

He was tired, lame and stiff. It was near midnight when he quit work the previous night, and now he was leaving his home at six-thirty in the morning to get back on the job, for he knew from past experience that this heavy snow would put Crossover terminal out of commission unless he got on the job early.

It was a dog's life—work, eat and sleep. What pleasure did he get out of life anyway?

Stepping on a slippery piece of ice concealed by the snow, he slipped and fell, wrenching his back in his efforts to save himself from falling. Then the pop valve blew off, for what he said is not printable. Picking himself up and wiping the snow from his face, he continued on his way in a frame of mind that spelled disaster to any one who crossed his path that day.

Going to the ash pit first, he found it plugged—tied up tight with a long string of dead engines. It took some time to straighten out this tangle before he reached the roundhouse. There, too, he found a general tie-up.

Crossover only had a 24-stall roundhouse, and it required mighty close figuring to keep business moving. It was the terminal of three important busy divisions, and the company had for years talked about erecting larger and more modern terminal facilities, but so far they had managed to worry along with conditions as they were, although far inadequate to handle the business even under normal conditions.

For nine years Jim Dugan had been general foreman at Crossover, and during that time he had become so familiar with conditions that he was able to quickly straighten out any congestion within the scope of human intelligence. He had made a reputation in handling Crossover.

It was nearly noon before he reached his office, and by this time he was dead tired. Hurriedly glancing over the accumulation of messages and correspondence, he came to one letter which made him sit up and whistle. It was a circular letter sent out from headquarters and announced that Mr. Joseph Harris had been appointed general master mechanic of numbers one, two and three divisions. Yes, the three divisions of which Crossover was the all-important apex. And Joe Harris, his old side partner, too.

His first thought was that Joe Harris was a lucky man. Then, as he again read the letter announcing the appointment, his mind wandered back to the time, 20 years ago, when he and Joe Harris started to work as apprentice boys. They both began their apprenticeships on the same day and in the same shop.

Later as mechanics they worked in the same gang, side by side. Then he had been appointed gang leader and had drifted away from Joe. Shortly after that Joe Harris had quit the road and gone to another railroad. Then they had lost sight of each other entirely. In the meantime he had stayed with the company and had been promoted from gang leader to foreman, and then to roundhouse foreman, and later to general foreman at Crossover, where he had now been for the past nine years. To be sure, he had received no sensational promotions, but he had slowly climbed the ladder of success, and if there was to be a new general master mechanic the job belonged to him by rights. He was the oldest employee and he had demonstrated his ability and loyalty on the road, so why did the company pass him by?

These thoughts filled his mind with resentment and anger. It was a fine way to show appreciation of meritorious service, holding a man down all his life, just because he could handle a terminal that no one else could handle. Several times in the years gone by there had been promotions made which rightfully belonged to him, but the officials had smoothed the matter over by either raising his salary or else bluffing him into believing that no one else could handle Crossover as he could and that he was such a valuable man at the terminal they could not move him without sacrificing the best interests of the company.

Brooding over these incidents, in addition to this last

What He Said Is Not Printable

insult, Jim Dugan made up his mind that he would quit right now before he was too old to secure a job elsewhere. Picking up a message blank he started to write out his resignation when the clerk poked his head in the office door and informed him they had just backed an engine into the turntable pit.

Instantly Jim forgot all about his resignation, for he must get into immediate action. With the turn-table blocked his office was no place for him to be in. He must get on the job and get busy. Giving instructions to his clerk to call the wrecking crew, he rushed out to the turn-table.

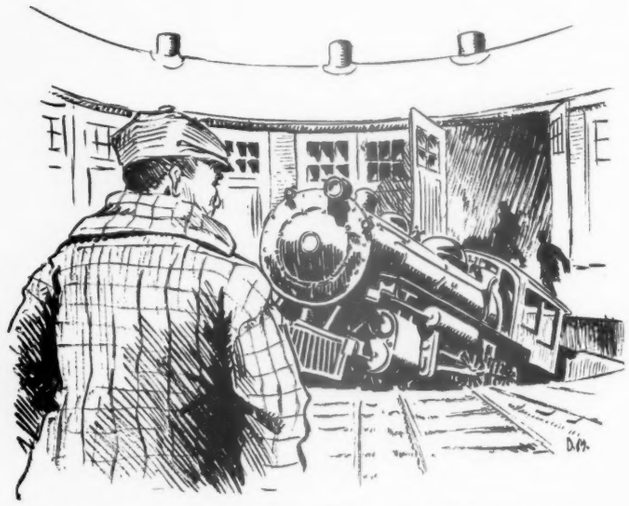
By the time he again had things moving it was mid-

afternoon. He went to his office for a little rest and, stretching out in his office chair, he prepared to take a little nap. His office was hot, close and the air stuffy, hence in a few minutes he was sound asleep.

Suddenly he was awakened by his clerk, who told him that the superintendent of motive power had just gotten off No. 4 at the depot and was headed for the roundhouse.

Picking up his gloves, he saw his partly written out resignation. What an opportunity. Now he would tell the S. M. P. right to his face that he was quitting. He would not send a message, for that would be too brief. He had a lot of things he wanted to get "off his chest," and now was the chance.

Going out through the house he met the S. M. P., and they began to talk over several routine matters. At last



They Had Just Backed An Engine Into the Turntable

they reached the office, where it was quiet, and then Jim opened up. Somehow he couldn't say the nasty things he had in his mind, but simply told the S. M. P. that he was disgusted and was going to quit.

The S. M. P. showed his surprise at what Jim was saying and finally stopped him.

"Look here," he said, "you have never showed us that you were worthy of promotion. You have been here so long that you are in a rut. What we want in a man is progress."

"Does not nine years' successful service show some progress?" asked Jim.

"In a way it does. Just stop a minute and look at yourself. You have been here nine years. During that time you have kept things moving. But they were moving before you came here. You haven't done anything out of the ordinary. If we made you general master mechanic you would take the job just as it is and you would carry it along just as it is. We need action. We need a man who can see ahead and who can do things that will cause some notice. You are a follower—we want a leader," replied the S. M. P.

"But how can I show that I am a leader, buried here in this out-of-the-way place?" asked Jim.

"There you go. That's just the answer to why you are here. You cannot see—you want some one to point the way. When I got off the train this afternoon I knew you would have business going here at Crossover. Some other fellow would be tied up tight, perhaps. In other words, he would have done something to cause notice. Of course, if always bad, we would fire him, but if something of a complimentary nature, in time we would have to promote him. Crossover moves every day the same, nothing new or startling, and you move with it—neither up nor down. Show us that you can get out of the rut and I will be the first man to shove you ahead."

There was no answer to this argument. Jim Dugan could see how true it was. He had buried himself; for nine years he had been his own worst enemy. When first he had taken hold of Crossover he had made a few half-hearted attempts to introduce new ideas, but as he had had no support from headquarters he had given up and slipped back into a rut, until now he was standing still. He would get support now.

"I will not resign, but from today on I shall act as if I had just been appointed to my present position. You are to know me not as Jim Dugan of the past nine years but as Jim Dugan with a future before him," said Jim.

"Let's shake on that," was all the S. M. P. could answer.

Jim Dugan faced a task. Many times during the next few weeks he was at the point of giving up, but he would grit his teeth and mutter, "I'll show him."

And as he progressed he began to feel ashamed of himself. Jim Dugan saw many of the little things which had escaped his notice in the past and which now loomed up big before him, as standing in the way towards successful management. He gave up taking his mid-afternoon nap—

"The S. M. P. Just Got Off No. 4"

one of the bad habits into which he had fallen. He spent less time in the road foreman's office visiting with engineers. He dug into engine failures personally. In the past his clerk had conducted such inquiries, but now he did the work. Much to his surprise, he learned a lot. He found conditions that should be corrected. He saw opportunities for new designs of equipment that would better the power. All these and many other recommendations he sent in to the head office, where they were simply acknowledged, but no action taken on them as far as he could see. But he did not

become discouraged—he kept plugging. He had made many changes at Crossover. His costs were decreasing, his men were satisfied—he was now making a record.

He heard that a certain type of engine was giving all sorts of trouble on one of the other divisions. He asked to have them assigned to his division so that he could study them. Soon he located the trouble, corrected it, and the engines were a success.

Many nights when he went home he was dead tired, but in the morning he was always anxious to get back on the job, for there was some question that always needed his personal attention. Where life had been a drudgery it was now a pleasure. He looked for engine failures with joy, for it would give him a chance to check up and conquer. But engine failures had stopped, so he turned to other things. He tidied up the place, he painted, he did a thousand and one things to place Crossover on the map—and he succeeded.

One day he received a message; "Report to headquarters tomorrow a. m.," was all it said. He wondered what it was; nothing to fear anyway.

When he reached the S. M. P.'s office he met the general manager, who greeted him with, "Hello, Jim, how does it seem to have a real job now?"

Bewildered, Jim looked to the S. M. P. for an answer. "Oh! yes, Jim, I forgot to tell you, that you are general master mechanic of numbers, one, two and three divisions," said the S. M. P. in answer to Jim's look.

"Well, I don't know whether or not I want to leave Crossover," replied Jim turning and looking at the general manager.

"Ain't that hell," said that worthy official, "it's hard to get a good man and we certainly need a man like Dugan for general master mechanic."

"Dugan will take the job, I know, for that's a little understanding we have between ourselves," said the S. M. P. as he slyly winked at Jim.

HEAT TREATMENT OF STEEL IN THE TOOL ROOM

Equipment and Methods for Tempering Carbon and High Speed Steel, Hardness Tests and Service Records

BY M. H. WILLIAMS

THE art and methods of hardening and tempering tools, such as are made in railway tool rooms have received a great amount of attention in the last few years, and as a result there has been a decided improvement in the wearing and lasting qualities of these tools. In many cases, in order to bring about this desired result it has been necessary to change practically the entire method of handling the work.

Not many years ago it was the custom for the blacksmith to harden and temper all tools, the heat being governed almost entirely by observing the color of the tool, both when hardening and when drawing the temper. These men became very expert at their work and produced results that at the time were considered satisfactory. As the art of steel making advanced and methods of testing tools were introduced, it was found that by the older methods, even with the most expert workmen, the wearing qualities of tools did not equal the results obtainable or demanded.

The present good results may be attributed principally to the gradual improvement in furnace design, devices for recording or measuring the heat, instruments that will measure the hardness of the tool after tempering, and last but not least, the records that are made of tools when hardened, the latter giving a brief history of the kind of steel, heat treatment, hardness, etc. In the event that a tool does not stand up properly the records may be consulted and the next lot modified in the treatment to overcome the defects. These records are also valuable when a new design of tool is to be hardened, as by consulting them, data concerning tools of similar nature may be considered and the treatment arranged accordingly.

TEMPERING SHOULD BE DONE IN THE TOOL ROOM

The question of the location of furnaces for tool hardening has been the subject of considerable study. In the past it was the custom to do practically all tool hardening in the blacksmith shop, often in open forge fires. This has proved bad practice when compared with more modern methods, later investigation having sown that it is advisable to locate furnaces for this work in the tool room. In this location the work will be under the eye of the tool room foreman, which makes him responsible for the entire manufacture. This location in turn brings up the question of men for the work. On account of the different natures of tool hardening and ordinary blacksmith work it is difficult to find much similarity in two crafts. Generally there will be found enough tool hardening in railway tool rooms to justify the employment of a man for this work only, who can make a study of hardening and tempering and devote his entire time to it. This employee may have been employed at hardening by the older methods. If such a man is not available, a man entirely new at the work may be employed, who should work according to rules laid down by the foreman, who in turn may obtain practically any information desired concerning the average hardening and tempering of tools from catalogues of steel manufacturing companies, text books, or the greatest educators of all in this line, the very efficient agents who travel for the steel companies and who are always ready to give instructions as to hardening, and also to do the actual hardening and tempering for demonstration purposes. Here the value of records comes in. When an expert hardens a tool a complete record should be made at once, so that when it is necessary to harden a similar tool, all the data will be available.

To those who have not made a trial of the scheme of employing men who are not experts at this work it may appear dangerous. However, with present day methods, it is the custom of several tool-making concerns to instruct the hardener as to the time the tool should remain in the furnace, the temperature to maintain, the quenching temperature, the quenching liquid, time and temperature for drawing the temper, etc. The data for issuing these instructions is taken from card records of similar tools hardened or the sources of information mentioned above.

HARDENING FURNACES

It goes without saying that good furnaces that may be maintained at a uniform temperature are necessary if satisfactory results are to be obtained. At the present day a furnace that cannot be maintained within 10 deg. of the desired temperature cannot be considered satisfactory, and with a number of

the later designs this is obtained without any great amount of care on the part of the operator. Several makes of combined pyrometers and heat regulators are now on the market for automatically controlling the supply of gas or electricity used by the furnaces. By the use of these devices, temperatures are maintained as desired, with but little attention on the part of the operator. Where additional furnace equipment is contemplated for use with gas fuel or electricity these regulating devices should be carefully considered.

For all around tool room furnace hardening natural or city gas appears to meet the requirements better than other fuels. With properly constructed furnaces and a good supply of gas, the heat may be controlled to a nicety, and it is unnecessary to erect a stack except in very badly ventilated rooms. In some locations gas is not available, making it necessary to use fuel oil, coke or the more desirable method, electricity.

A furnace for tool room hardening, making use of any fuel, should be so constructed that the direct flame does not come in contact with the article to be hardened. This desirable condition may be accomplished by making use of a combustion chamber in which the gas and air, or oil and air, after leaving the burner and before entering the heating chamber thoroughly combine and form a hot gas, which in turn enters the heating chamber. The result, if a well designed combustion chamber is provided, will be that in the heating chamber there will not be any appearance of a flame, but simply an intense red heat surrounding the article to be hardened equally on all sides, resulting in an even heat, which is very essential. Furnaces in which the flame is visible cannot be considered satisfactory, and they should be rebuilt or renewed.

One of the very satisfactory forms of gas furnaces is constructed so that the gas and air combine in the combustion

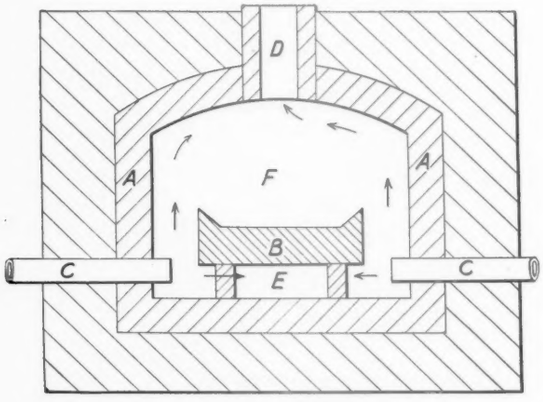


Fig. 1. Cross Section of a Typical Gas Furnace

chamber below the hearth as shown in Fig. 1, in which *AA* are the walls lined with firebrick, *B* the hearth supported from the bottom of the furnace on piers of fire brick, *CC* the burners, and *D* a vent at the top. With this furnace the gas and air after combining at the burner, enter the lower chamber *E*. This gas mixture passes up between the hearth *B* and the walls of the furnace and into the heating chamber *F*. As a result the article to be hardened does not come in contact with the direct flame. The pyrometer when used in this furnace generally enters through a hole in the rear wall. In order to properly equalize the heat it is customary to locate burners on each side.

In many cases gas furnaces not equipped with combustion chambers may be rebuilt to obtain the benefit of the lower combustion chamber by building a hearth of firebrick resting on piers of like material. Several good makes of gas furnaces are now on the market that may be purchased at reasonable prices, and it will often be found more economical to order one of these than to attempt to rebuild present equipment.

OIL FURNACES

Many railway shops are located where gas is not available. It then becomes a question of making use of fuel oil, kerosene, coke or electricity, electricity being without a doubt the best suited for the purpose. However, in cases where this can not be obtained at reasonable rates, it is often necessary to resort to other fuels.

A number of designs of oil-fired furnaces are employed. One very satisfactory type, known as the oven-fired, is shown in Fig. 2. This design has a combustion chamber *A*, heating chamber *B*, a perforated arch *C*, a hearth *D*, set above a waste heat duct *E*, and the customary roof *G*. The burner *F* is placed at the side. The walls *HH* are supported on suitable legs or built up solid from the floor. The leg construction is more desirable for small sizes generally used in tool

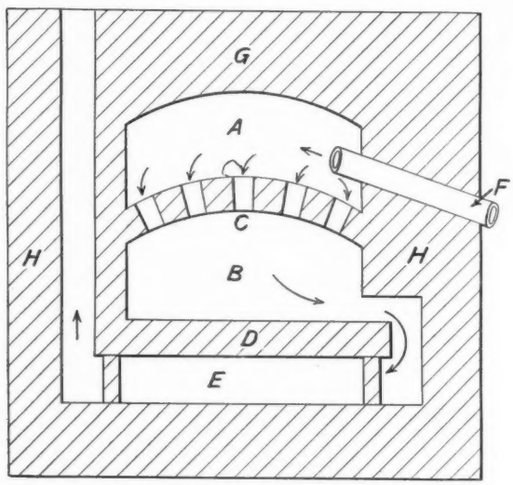


Fig. 2. Oil Furnace of the Over-fired Type

rooms. As ordinarily constructed, the hearth is supported from the floor of the furnace by fire brick pillars, the duct underneath connecting with the vent duct shown. Also an opening is made from the heating chamber into the duct *E*. The arch *C* is made of perforated firebrick such as is supplied by makers of this material. The oil burner and the necessary air connections are generally inclined slightly so as to direct the flame above the arch *C*. The direction of the flame is indicated by arrows. In the combustion chamber the air and oil after leaving the burner combine and form a hot gas that passes downward through the perforated arch and into the heating chamber in which the articles to be hardened are placed, the waste heat from the heating chamber passing through the duct *E*, which also heats the hearth, and up through the side vent. A furnace of this nature is often used without a vent to the roof in well-ventilated rooms. The pyrometer, as in the case of the gas furnace, is passed through an opening in the back wall. This form of furnace may be maintained at a fairly uniform heat, provided the supply of oil and air is regular, and will, as a general rule, be found as satisfactory an oil furnace as any design made. The consumption of oil may be somewhat greater than other forms. However, the consumption of fuel for tool hardening is always secondary to satisfactory results.

ELECTRIC FURNACES

There are a number of types of electric furnaces that are giving most excellent results for tool room hardening. In fact, the results are so very good that their installation should be carefully considered in any railway tool room where the

proper current is available. One very satisfactory type is the Hoskins, shown in Fig. 3. This is made up of a heating chamber *A*, at the top of which is placed a carbon connecting plate *B*. Two piles of thin carbon plates *DD* form the sides. These rest on graphite bottom plates *EE*, which in turn rest on the adjustable electrodes *FF*, which are controlled by the adjusting screws *GG*. These electrodes *FF* are kept cool by water circulating through the clamps *HH* and pipe *I*. The bottom of the furnace or hearth is made up of some insulating material, such as cement. The electrodes *FF* are surrounded at the lower end by asbestos packing, and at the top by sand, in order to form an air-tight seal and allow for the movement of the electrodes. All these elements are surrounded by a heavy wall made up of heat-resisting material, and as a result very little heat escapes to the room.

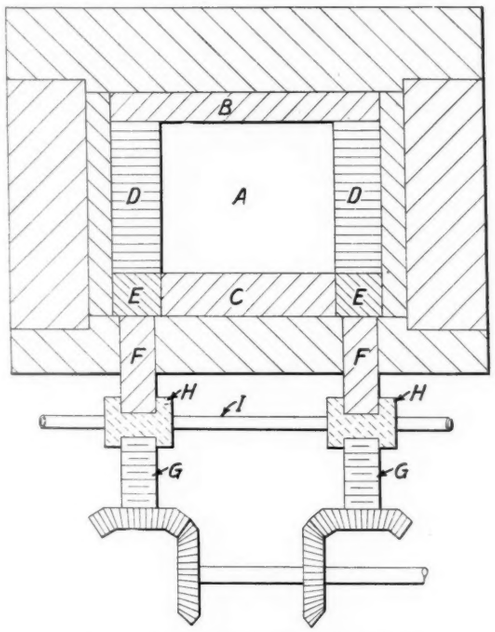


Fig. 3. Carbon Plate Electric Furnace

This furnace works on the electric resistance principle. That is, a poor passage for the electric current is purposely provided, which results in heating these conductors. Or to make use of a comparison, it is on the same general principle as the electric heater used in electric street cars or the electric flat iron. In this case the carbon plates *DD* at the sides of the furnace offer considerable resistance to the passage of the current, and as a result they are heated according to the amount of current passing and the resistance they offer, this heat being radiated into the heat chamber. The passage of the current is as follows: Starting at the right hand side, the current from a transformer is connected to the clamp *H;* it then passes through the electrode *F* to plate *E*, to carbon pile *D*, to top plate *B*, and over and down to the left hand clamp *H*, in a similar manner, and to transformer.

By varying the pressure applied to the adjusting screws *GG*, the resistance to the passage of the electric current through the carbon plates *D* may be varied, which in turn governs the amount of heat transmitted to the heating chamber. The furnace takes its current from a special transformer wound for low voltage and high current. This, however, may be connected to the regular alternating current shop lighting or power circuits. It can not be used on direct current circuits. When starting, the current is switched on and pressure on the screws *GG* adjusted to obtain the correct flow of current. When the proper heat is once obtained very little adjusting is required to maintain a uniform heat. A pyrometer is used to indicate the heat of the heating chamber, similar to the practice with oil or gas furnaces. With this furnace there is but a very small amount of oxidizing or scaling of the work, owing to the fact that the air does not enter the heating chamber. It is suitable for either carbon or high speed steel, and on account of the small amount of heat radiated from the walls, may be located in tool rooms in close proximity to other tools or workmen. It has the advantage that a chimney is not necessary.

ELECTRIC BATH FURNACE

Another design of electric furnace that has been used to a limited extent in railway tool rooms makes use of a salt bath. In this type of furnace certain grades of salts are melted by the passage of the electric current through them. The articles to be hardened are immersed in the salts similar to practices with lead furnaces. Fig. 4 shows one form of electric bath furnace. This is made up of a crucible *A*, generally of fire clay or similar heat-resisting material that is a non-conductor of the current, on two sides of which are placed electrodes *BB*. A hood with a vent to the roof is necessary to carry away the gases and fumes, which are injurious to the operators. In practice, the crucible is filled with some form of salt, such as sodium nitrate and sodium chloride for the lower temperatures, and a mixture of potassium chloride and barium chloride for temperatures generally used when hardening carbon steel, or barium chloride only for high speed steel, the proportions of these mixtures being varied to suit the conditions and temperatures required. The proportions of each are given in instructions furnished by makers of the furnace.

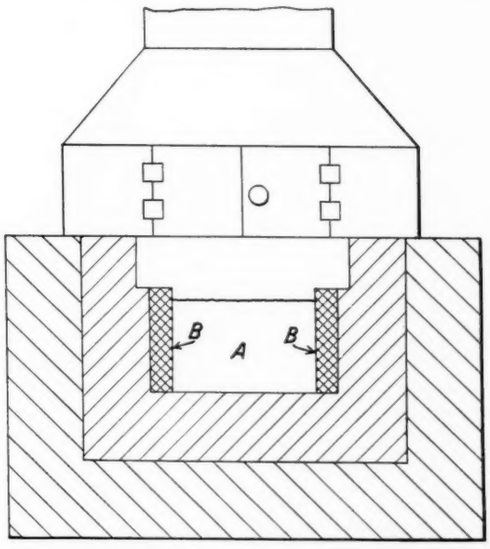


Fig. 4 . Electric Bath Furnace

These salts when cold are non-conductors of electricity, but when hot, readily conduct the current. In starting, it is customary to connect a piece of electric arc lamp carbon to one of the electrodes by a wire and strike an arc in the salt near to the opposite electrode. As the salts melt, the carbon is gradually drawn away from the electrode. This forms a canal of melted salt, which conducts the current. With the current once started across, the entire mass soon becomes liquid. It is customary to keep the furnace hot at all times, which is accomplished by allowing a small amount of current to flow during the night or when not in service. The electrodes *BB* are made from pure wrought iron and are led in over the top of the crucible and down into the salt bath. These are connected to the secondary of a special

transformer, that is arranged with suitable taps and switches so that the required amount of current may be obtained, the current being shown by an ammeter. The temperature of the bath is ascertained by a pyrometer, the fire end of which is placed in the salt bath.

The work to be hardened is hung on wires and immersed in the bath and rapidly takes the same temperature. After immersing a sufficient length of time to insure complete penetration the work is withdrawn and quenched in the usual manner. Or in case of special intricate pieces they are allowed to preheat on a shelf above the bath before being placed in the solution.

This form of furnace is especially useful for carbon steel and has several good points, of which the following may be mentioned. On account of the exclusion of air from the piece while it is immersed in the bath there is no oxidation, and when it is removed from the bath a thin film of salt adheres to the surface. As a result, pieces hardened show no signs of scale. This is very desirable, for taps, dies, gages and special tools. On account of the large mass of heated salts, the furnace does not cool down to any great extent when work is placed in it. For carbon steel it gives most excellent results and is to be highly recommended. For high speed steel it is necessary to renew the electrodes at frequent intervals, and it becomes a question of whether this furnace is a paying proposition. Before installing, it is advisable to look into the question, as the art of heating by electricity is advancing so fast that it is dangerous to say one day what will be done in the next.

This furnace, like the one previously explained, gives out very little external heat, and can therefore be placed in tool rooms. On account of the fumes, a chimney must be provided.

BATH FURNACES OR LEAD BATHS

Certain long articles which are made in railway tool rooms, such as stay-bolt taps, taper frame bolt reamers, etc., cannot well be hardened in the customary tool-hardening furnaces without constructing them too large for the average demands. Also, on account of their comparatively great length, it is difficult to obtain a uniform heat over the entire tool in the average furnace. To overcome this difficulty the lead bath or salt bath is employed. As a general prosposition, of the two methods the lead bath appears to meet the requirements better, all things being considered.

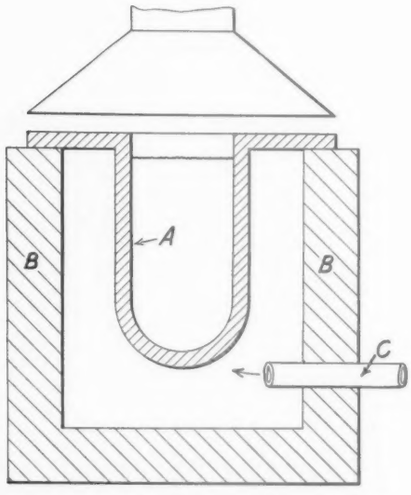


Fig. 5. Lead Bath for Heating Tools

One form of this furnace is shown in Fig. 5, where *A* is the pot, which for use with lead is generally made of cast iron or seamless steel tubing closed and welded at the lower end and flanged at the top to rest on the brick casing. The seamless tubing construction is much preferred on account of its longer life. The circular brick work *BB* forms the wall of the furnace, and is lined with firebrick, the diameter of the inside being sufficient to allow the flame to readily pass around the pot. A burner *C*, that may be used with gas or oil, is provided, that directs the flame below the pot. A hood *D* for carrying away the fumes given off by the lead is quite necessary on account of the poisonous nature of these fumes, although by keeping the top of the lead covered with powdered charcoal the fumes are very much reduced. A pyrometer is generally placed in a vertical position in the pot, care being taken not to allow it to touch the pot.

In practice the pot is filled with lead or some suitable salt, such as a mixture of barium chloride and potassium chloride, and heated to the required temperature as indicated by the pyrometer. Articles to be hardened are immersed in the bath and allowed to remain until heated to the same temperature as the bath, when they are withdrawn and quenched in the customary manner.

There is always the possibility where lead is used of small particles of lead adhering to the surfaces, which interferes with the proper hardening of some tools, such as stay-bolt taps, by reason of the cooling medium, such as water or brine, not reaching the steel, resulting in soft spots. To guard against this several methods are employed, one being to paint the article with a mixture of common whiting and wood alcohol, or whiting and water. If the latter is used it is necessary to dry the piece thoroughly, otherwise the lead will fly and may injure the operator. With the salt bath this is not necessary.

There are a number of advantages to be gained by the use of the lead bath furnaces as compared with ordinary gas or oil-fired furnaces. On account of the entire absence of air surrounding the tool while hardening there is no scaling. This is very essential for taps. On account of the large volume of lead the temperature can be maintained within close ranges and is very little affected when placing cold pieces in the bath. In addition to taps these furnaces are used quite extensively for hardening drills, reamers, flue tools, chisels, etc. For articles like chisels and rail cutters, where it is desirable to heat only a part of a tool, the lead bath gives most excellent results, and is so much superior to the ordinary open fire as to warrant its installation for this purpose only. Therefore, it may be said that no railway tool room is complete without the lead or salt pot furnace.

SCALING OF TOOLS DURING HARDENING

Scaling or oxidation of tools during the hardening process is objectionable, especially where they are of a nature not admitting of grinding after hardening, such as taps, gages, etc. This scaling follows as a result of air or oxygen entering the heat chamber and being absorbed by the steel while at the higher temperatures. With practically all forms of furnaces, with the possible exception of the salt or lead bath, a certain amount of scaling is bound to take place while the tools are in the furnace and during the short interval between removing from the furnace and quenching. Proper regulation of the air used with gas or fuel oil will have the effect of reducing the amount of scale. In order to approach the desired results it is necessary to obtain as nearly perfect combustion as possible before the flame enters the heating chamber. This is accomplished to a greater or less degree by proper regulation of the flow of air along with the fuel used. This makes a uniform pressure of air very essential. The use of air from the average blacksmith shop blower line is objectionable on account of variations in pressure, resulting from the intermittent use of forge fires. High pressure air, such as is used for air hammers and similar tools is also not to be recommended on account of uneven pressure and from the cost standpoint. Where this

must be used the conditions may be improved by the use of suitable reducing valves between the shop line and the burners which, let us say, will reduce the pressure down to 20 lb. This will give a uniform pressure at the needle valve of the burner even if the shop line pressure varies.

Where possible, a separate fan should be installed for tool room furnaces. In order to obtain proper combustion with gas or oil a pressure of about 10 ounces should be available. This is generally greater than the average blacksmith shop line. Where fuel oil is used it is also necessary to obtain a uniform pressure in order to feed the burners at a uniform rate. This may be accomplished in most cases by erecting a stand pipe or tank near the furnaces.

Furnaces for this work should be kept as tight as possible both in the walls and doors. Special care should be given the latter, as in the event of air entering, the scaling will be increased. One very good scheme to insure a tight door is to build the door side of the furnace on a slight incline, say about 10 deg., and hang the door to slide against this surface. With proper hanging for the door it can be so arranged that when down it will make a very good surface contact with the furnace, and when lifted will draw away from the wall. With this form there is no need for guides for the door, on account of the door only resting against the furnace. In the event of an explosion or puff of fire the door is blown outward without other damage. It is now customary to provide all furnace doors with self-closing peep holes. By opening these the temperature of the articles in the furnace may be judged by comparing the color with the pyrometer fire end. That is, when the tool and the fire end are one color both are at one temperature, a slight variation being quite noticeable when looking at both at one time. However, the fact that the tool on the outside is of the proper temperature does not indicate the time to quench, for in order to insure proper hardening the tool must remain in the furnace long enough after the outside is of the proper temperature to insure complete and uniform penetration of the heat all the way through.

FURNACES FOR TEMPERING OR DRAWING BACK

The oil bath and electric furnace, or electric oven as it is more properly called, are now largely used for drawing the temper of tools. By the use of either, very satisfactory

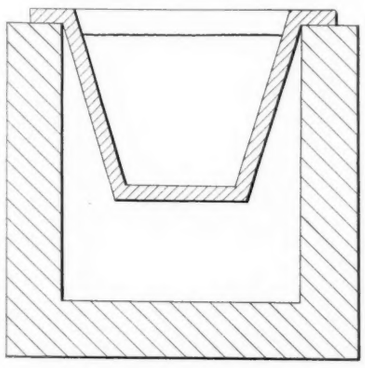


Fig. 6. Oil Pot for Drawing Temper

results are obtained, this method being very much superior to drawing the temper by observing the color of the tool.

The oil bath form shown in Fig. 6 is made up of a cast or wrought iron pot resting on a circular brick or cast iron wall or stove. Underneath the pot the necessary burners are placed for use with oil or gas, according to the fuel available. The pot is filled with a special grade of high fire test oil sold for this purpose by concerns making a specialty of these oils. The pot is provided with a hinged cover arranged so that it may be closed instantly in the event of the oil firing, when the closing of the cover smothers the flame. A glass bulb thermometer is generally suspended in the oil for the purpose of indicating the temperature. As it is often the practice to draw the temper of a large batch of tools at one time a chain block is often placed above the furnace for the purpose of lifting the baskets in which the tools are held out of the pot.

In practice several pieces of a similar nature which may be the result of a day's hardening are placed in the perforated basket and lowered into the oil bath, preferably when the oil is at a low temperature, say below 200 deg. F. The oil is then gradually brought up to the required temperature and held at this temperature from one to three hours in order to insure that all pieces assume one temperature and that the heat penetrates all the way through. The basket is then withdrawn and the work allowed to cool in the air. Placing the tools in the oil when it is comparatively cool eliminates the possibility of setting up local strains in the previously hardened tools and reduces the breakages as compared with placing the hardened tools in a furnace that is at a high temperature.

ELECTRIC DRAWBACK FURNACES

This form of furnace is now used quite extensively for temper drawing. Generally they are made up of a heating chamber very similar to regular hardening furnaces, the chamber being enclosed by firebrick or heat insulating material. The door is generally hinged on one side and made to fit very closely into the opening, being locked in a manner similar to the practice with stoves. The heating units, which are made up of electrical resistance wire, are placed at the sides of the heating chamber. The passage of the current through these units causes them to give off heat that in turn heats the oven. The heat is controlled by suitable rheostats or switches, and in some cases a thermostat is arranged to automatically control the heat to whatever degree it may be set. When the furnace comes up to the desired heat some of the heat units are cut out or resistance is added, which automatically controls the temperature to the required degree without hand control. In practice the work is placed in the oven and the temperature gradually brought up to the required heat and held there for the correct amount of time.

This form of furnace has several good points, of which may be mentioned the almost entire absence of heat in the room, a uniform temperature under good control, absence of smoke or smell, safety, and when provided with a thermostat, a uniform heat is obtained without hand regulation.

These oil bath and electric drawback furnaces have many advantages compared with the older methods. On account of the slow rate of heating there is not the danger of causing a fracture in the steel, and the heat penetrates to the center and insures uniformity throughout the piece. This is of particular value when drawing the temper of a piece of irregular shape or section. The method is much cheaper, as a large number of pieces may be drawn at one time without more attention than watching to insure the correct temperature. There is also a considerable saving on account of avoiding the necessity for brightening the work.

The temperatures agreeing with the various colors generally used for drawing back are as follows:

	Deg. F.	Deg. C.
Very pale yellow	430	221
Light yellow	440	227
Pale straw yellow	450	232
Straw yellow	460	238
Deep straw yellow	470	243
Dark yellow	480	249
Yellow brown	490	254
Brown yellow	500	260
Spotted red brown	510	266
Brown purple	520	271
Light purple	530	277
Full purple	540	282
Dark purple	550	288
Full blue	560	293
Dark blue	570	299

This table will serve to connect the various colors and temperatures. However, on account of the fact that heating in an oil bath or an electric oven is quite a different operation from drawing by colors, a certain amount of experimenting is often necessary in order to determine the correct temperature and time the tools should remain in the drawing furnace. When this information has once been obtained the results may be duplicated with great accuracy, and if shown on card records it should not be difficult for a person not familiar with hardening to obtain satisfactory results. This is much to be preferred to relying on some one man for this work.

PYROMETERS

The great advances in the art of hardening and heat treating of steel that have been made may be attributed very largely to the pyrometer. In fact, it would at the present time be almost impossible to get along without this valuable instrument. Any tool hardening plant without these is very much out of date.

Pyrometers are so universally used that a lengthy description cannot be considered necessary. The principal part of this outfit is the indicator, which is constructed as far as the working part is concerned very similar to volt meters, practically the only change being the size of wire used and the graduation of the dial, which is graduated for degrees Fahrenheit or Centigrade instead of volts or amperes. The thermocouple, or fire end, is generally made up of two wires, each of a different composition, the two being welded together at one end and connected at opposite ends to wires leading to the indicator. The wires making up the fire end are enclosed in a metal or porcelain protecting tube to prevent the direct heat coming in contact with the wires. When the joined ends of the fire end are heated a very feeble current of electricity is generated, which is indicated by the needle of the indicator. The scale of the indicator is graduated by the makers to read in degrees of heat according to the heat at the fire end. These fire ends, on account of continued heating, will wear out, for which reason it is customary to purchase several with each instrument. They are now made of two classes, one being known as base metal, made from steel wire or alloys, which are suitable for temperatures up to about 1,700 deg. F., and used very largely when hardening carbon tool steel or casehardening. These are not expensive. For higher temperatures, such as are necessary for high speed steel that may go as high as 2,400 deg. F., it is necessary to employ fire ends made from platinum and platinum-rhodium or similar metals. These are very expensive and can only be recommended where it is necessary to harden expensive high speed tools.

Pyrometers, like any delicate instruments, are liable to get out of order if abused or not given proper attention. It is customary to encase the indicator in a protecting case to exclude dust, and it should be mounted on a firm wall or support. This part of the pyrometer outfit is so well made that trouble rarely occurs. The thermocouple, or fire end, when made of any metal is liable to errors, and must be frequently calibrated in order to insure accuracy. The question of calibration will be considered later.

A pyrometer can be installed by the regular shop electrician who follows the instructions given with the instrument. The indicator should be located out of range of the direct heat of the furnace. The wires are generally run in conduit similar to lighting circuits. The fire ends are generally passed through the back wall of the furnace, a hole being made for that purpose. The fire end should not be removed except when making calibrations. Good practice generally indicates that a separate indicator should be used with each furnace, in which event they are banked on a suitable board secured to the wall of the building. By this method the temperature of all furnaces is under the eye of the hardener at all times.

For certain classes of service recording pyrometers are used. These make a record of the temperature very similar to the records of air and steam pressure in power plants. It is a question whether these are necessary in tool rooms where this work is under the eye of an expert.

There are a few points in connection with the use of pyrometers that should be carefully observed, one of these being the case of the hot and cold ends of the couple. The amount of current generated and the movement of the dial needle depend on the difference in temperature of the hot end, which is placed in the furnace, and the cold end, which is the opposite end of the couple. Generally these couples and dials are graduated to read correctly when the temperature of the cold end is at the average room temperature, or about 70 deg. F. If the cold end is too close to the furnace and its temperature is raised, the readings will be affected accordingly. That is, if instead of 70 deg. it is 100 deg., the readings will be 30 deg. low.

In order to overcome this difficulty it is now found to be good practice to run the wire connecting direct to the fire ends downward to the floor, on account of this location being little affected by heat from the furnace. One method followed with good results is to use wires from the outer end of the fire end to the floor, made of the same metal as the fire ends and join the copper wire to them in a junction box located at the floor, this junction box being similar to that used for electric wiring. This results in making a very long fire end where the cold end may be kept away from the heat of the furnace. Where this practice is followed great care is taken to secure good joints between the wires of the fire ends and the extensions.

Another method followed is to run the wires of the fire end, after leaving the furnace, in conduit, and surround this conduit by a second pipe, through which a stream of water flows which keeps a uniform temperature at the cold end.

It may now be well to consider what is to be gained by the use of pyrometers as compared with the older method of judging the heat by the eye. Books issued by known standard authorities on the subject of tool steel all call attention to the importance of correct temperatures when hardening and tempering tools. The more careful steel making concerns employ chemists and test department experts who make a business of testing tool steel in order to ascertain the correct temperature when hardening, in order to obtain the greatest strength, wearing qualities or resistance to shock and also grade the steel according to the use intended. The information obtained by these concerns is generally shown in their catalogues or can be obtained by letter, the most approved methods of treatment being set forth. This information will show that practically every different tool requires a different treatment and grade of steel in order to obtain the best results.

Steels that are similar in general make-up and trade name, but differ in carbon content, must be treated differently. The higher the carbon the lower the heat required. To take an actual case of one grade of tool steel. If .100 carbon it should be hardened or quenched from 1,350 deg. F. The same grade of steel but with .060 carbon should be quenched from 1,400 deg. F. This may not appear to be a very great difference. However, quenching only a few degrees from the correct temperatures will affect the wearing qualities of the tool and may result in one tool of a batch standing up well and another made at the same time from the same bar failing.

Generally speaking, in order to obtain the best results carbon tool steel should be quenched just after reaching the so-called decalescence point, which is a heat where the steel changes its nature. Or, in other words, the steel has

changed, and by quenching is held in this changed state. One peculiar property of steel is that at the decalescence point it becomes non-magnetic. Going to a higher heat will not improve conditions or make the steel enough harder to be of value. In fact, the results will be the reverse, as a higher heat will result in a coarse grained steel, which is always an indication of poor steel or treatment. Again, practically all tools must have the temper drawn after hardening. This being the case, nothing is to be gained by overheating the tool when hardening and drawing back this extra hardness in the tempering operation. Reasoning will indicate that the tool should only be heated just hot enough to harden it properly. In order to determine the proper heat it is necessary to be governed by reliable pyrometers.

For the purpose of ascertaining the drawback or tempering heat where furnaces are heated by a flame the regular pyrometer may be used. This method of procedure is but little followed at the present time.

For the electric oven and oil bath drawing, the glass bulb thermometer is now largely used. These are of special construction for the purpose, and are enclosed in a suitable protecting casing to prevent injury in case the articles being drawn strike the casing. These thermometers are made with a scale reading high enough for all ordinary drawback temperatures.

When used in an oil bath the bulb is immersed in the oil, or when used in an oven an opening is made in the wall through which the thermometer passes. These thermometers are generally very reliable and have the advantage that they will not change with age. However, even with the greatest care the glass will at times break, therefore it is always advisable to have an extra one on hand.

A study of the table of temperatures and corresponding colors that has been given will show the small difference in temperature between colors used when following the old method of tempering and will also serve to illustrate the necessity for accurate temperature readings and maintaining the oil bath and the oven at the proper temperature.

TESTING AND CHECKING PYROMETERS

A pyrometer to be of value must be properly calibrated and kept in order and a number of methods are followed for this checking. One way is to compare the work instruments with a standard instrument kept for checking purposes only. In this event the standard instrument is generally of the portable kind that may be carried where required. When used, the fire end of the standard instrument is placed in the furnace close to the work fire end, and when the two are of the same color, as may readily be detected by the eye, i. e., the same heat, the check and work pyrometer readings are compared. If they do not agree the work instrument is tagged, showing the amount high or low. The hardener then makes allowances to compensate for this error. In case the fault is in the indicator, this part may be repaired by the maker, or if an expert on this work is available adjustment may be made locally. This work, however, can only be done by an expert. Where a number of pyrometers are used about a shop a high class standard check pyrometer will be found to be a good investment.

Where the shop is not large enough to warrant a standard check pyrometer other means of checking are followed, one method being to compare the pyrometer with the thermometer used in the oil bath. This is done by immersing the fire end in the oil bath alongside of the thermometer and comparing readings. This will check up to the limit of the heat of the oil, which is rarely over 650 deg. F. This method is fairly accurate, as the glass thermometers are generally correct within a small error. It has the disadvantage that the pyrometer is not tested at the average working temperature for carbon steel, which is generally between 1,350 and 1,450 deg. F., and if the indicator is in error the chances are that the reading will not be correct at the higher readings. However, one of the principal causes of error is the gradual wearing away of the fire ends, owing to heating and cooling, and as a test of this nature will show these errors, and can be made very quickly, it is recommended as a frequent check.

Certain minerals and salts are known to have a clearly defined freezing point, or, in other words, the point where it hardens, just as water freezes at 32 deg. F. One of the most reliable substances is salt, which freezes at 1,472 deg. F. This temperature is close to the average hardening point of carbon steel, and is therefore often used. A very satisfactory method of testing the accuracy of a pyrometer with salt is as follows: For the purpose of melting the salt a graphite crucible should be used when it can be had. Suitable tongs or bale should be provided for lifting it in and out of the fire. As a makeshift a sort of deep frying pan may be used that can be made from steel as follows: A four-inch bar of steel five inches long is drilled about four inches deep with a three-inch hole, a handle being welded to it. These pots are then filled with salt and placed in a furnace or forge fire and heated until the salt melts. The fire end is then placed in the melted salt and allowed to remain there while over the fire until the salt and fire end are of the same color and heat. This may take several minutes, the fire end being connected to the indicator while this is going on. The pot and fire end are now removed from the furnace and allowed to cool. As the salt cools readings should be taken each 10 seconds, or, better still, a curve made on cross-section paper, the temperature being set down on horizontal lines and the time on the vertical lines. When the salt freezes the needle of the pyrometer will remain stationary for a few seconds, this freezing point being clearly defined and can be detected very readily. After a few seconds the needle will again go backwards. The pot should then be placed in the fire and heated to remove the fire end, after which the salt should be washed off as it is injurious.

It is important that the cold end of the fire end be kept at the room temperature while this test is being made. If the pyrometer reading differs from 1,472 deg. F., the instrument is tagged accordingly. It is necessary to obtain pure salt for the purpose of making this test. Generally the common grade known as table salt will be found reliable. However, where there is a laboratory in connection with the shops it is advisable to obtain salt of known purity from that department. In any event, the salt must be kept clean and free from other impurities which will affect its freezing point.

QUENCHING TANKS

In order to properly harden the great variety of tools such as must be made in these tool rooms several quenching tanks are necessary, all of which must be of ample size in order to guard against a too rapid heating of the quenching solution and to maintain a uniform temperature of the liquid. Unless this solution is maintained at the correct temperature the variations will have a marked effect on the hardening. Generally speaking, tanks 36-in. by 36-in. by 36-in. of ¼-in. material, preferably with seams welded, meet the requirements in a very satisfactory manner. These should be provided with hinged covers that may be closed when the tanks are not required, in order to keep out dirt and foreign matter.

The following quenching mediums are recommended: clear water, salt water or brine, and oil. For the larger rooms it is advisable to install two tanks for each of these solutions in order to be able to alternate from one to the other as the solution becomes warm. In many cases cold water or steam pipes, or both, are placed in these tanks for the purpose of maintaining a uniform temperature. By

making proper use of the water or steam the liquid can generally be kept near a uniform temperature. As an illustration of the value of this, suppose it is necessary to harden a large batch of tools at one time similar to flue tools. If proper provision is not made to maintain a uniform temperature of the water or oil used the first of the tools quenched in the colder solution will be the harder, and while this may not be a very serious question, it is desirable to harden all tools of a batch alike, and as this can be accomplished readily by the use of proper cooling coils it certainly is worth while making provision for them. For some classes of hardening, especially nickel steel, it is often necessary to warm the water to possibly 200 deg. F. in order to prevent too rapid cooling. The same holds good where it is necessary to harden a piece of irregular section or where there are a number of sharp corners where warming the solution will prevent cracking the piece quenched.

The location of tanks with reference to the furnaces is also important. Where possible it is advisable to place these all in a row facing the furnaces with a space of some six feet between.

When hardening articles having concave surfaces similar to drop forging dies, or hollow articles such as hollow mills used on screw machines, it is advisable to equip one tank with a nozzle or spout which may be made of gas pipe loose jointed to enable the stream to be changed to meet different conditions. When hardening, the stream can be directed on the surface requiring the hardest surface to insure proper results.

In addition to the quenching tanks an air blast for high speed steel hardening should be provided. The mistake should not be made of using compressed air from the shop line without a reducing valve to cut down the pressure.

THE SCLEROSCOPE

No tool room can be considered complete without a scleroscope, this being an instrument for measuring the hardness of metals. It was the custom at one time to test all tools after hardening with a file. This was a rough and ready method that would tell when a tool was too soft but would not indicate when it was too hard or how much too hard or too soft. By the use of the scleroscope the exact hardness of any tool may be measured with great accuracy. This makes it possible to test the hardness of tools, and in case they are not correct, to modify the method of hardening and tempering.

This instrument works on the principle that if a weight that has been very carefully made as regards size, weight and shape of point be dropped from a uniform height the rebound of the weight when striking any substance will be governed by the hardness of the substance hit. This can best be illustrated by a homely comparison of dropping a marble. Suppose a marble is dropped on a wooden floor. The rebound will be a certain amount. If the same marble be dropped from the same elevation on a concrete floor the rebound will naturally be much greater on account of the increased hardness of the concrete as compared with the wood floor. This same principle is used in the scleroscope, which is so constructed that the weight will always be dropped from a certain predetermined height. By observing the height of the rebound on the scale the actual hardness of the metal is determined.

This instrument, which is shown in Fig. 7, has a glass tube *A*, with a scale graduated to 140 equal divisions much like a thermometer. Inside this glass tube is placed a small weight having a sharp-pointed diamond set in the bottom, this weight being free to move inside of the glass tube. For the purpose of raising the weight the soft rubber bulb *B* is squeezed and then released. The vacuum above the weight lifts it to the top of the tube, where it is caught by a catch in the round cage at the top of the instrument. When the bulb is pressed the second time the weight is released and falls, striking the object to be tested, and then rebounds, the amount of rebound being noted on the scale, which may be easily read. This rebound may indicate 40 for soft steel, 60 to 70 for the ordinary chisels and flue tools or possibly as much as 100 for extra hard tools. A magnifying glass, as shown, is employed, which assists when making close readings.

The instrument is leveled by leveling screws *E* and may be raised or lowered by turning the knurled nut *F*. The rod *D* acts as a plumb bob to show when the glass tube is perpendicular. Small articles are placed on the platform *G*. The glass tube is then lowered by means of the nut *F* until

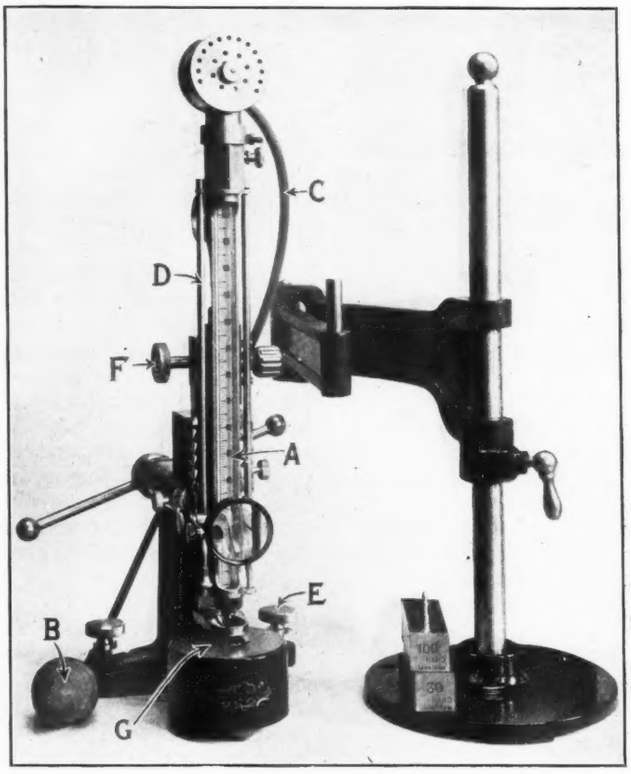


Fig. 7. The Scleroscope

the metal at the end of the glass tube rests on the piece to be measured. The weight is then raised, allowed to drop and the amount of rebound measured.

When it is necessary to test articles that are too large to go on the platform the instrument is held in a swinging bracket and located above the point where the tests are to be made. In this event, it is customary to hold the article in a vise or rest it on the work bench or an anvil.

The graduations on the glass tube have no particular meaning. However, they are similar on every instrument made. Therefore, readings made from any instrument will be alike when measuring the same hardness of steel. This makes it possible for one shop or the engineering department to instruct other shops having similar instruments as to the hardness of tools and also to compare results from time to time.

This instrument should be used for testing the hardness of each tool made in the tool room. The result will be that tools not properly hardened will not get into service. A record should also be made of each tool or batch of tools. From this the tool room foreman can tell just how hard a tool was made. If it has stood up well the hardness may be set as a standard and future tools hardened and drawn to

the same degree. If a tool when in service was found too hard or too soft the next ones made can be varied to meet requirements, the records being consulted to find the hardness of the defective tools. As an illustration, take the case of a flue beading tool. This should not be too soft or the throat will batter up; or too hard, as it will break. The scleroscope will measure this hardness, which for this tool should be between 60 and 70, as shown on the scale. Cutting tools, such as drills and taps, are generally harder and may show 80 to 90. This instrument is very valuable for high speed tools, as an expensive high speed tool, such as a milling cutter, drill or reamer, may be readily broken if too hard. The mistake is often made of not properly drawing the temper of these tools under the impression that high speed steel must be very hard. The scleroscope will detect where these tools are too hard and often prevent costly breakages.

In many shops it is the practice to test each tool made with this instrument in order to pick out tools that may not have been properly hardened and which is also a check on the entire operation of hardening, tempering and grade of steel. To make this test it is customary to grind a smooth surface on the tool, which may be done on a wheel or by hand, and make the test on this ground surface, the actual preparations and testing only requiring a few seconds. The knowledge that all tools leaving the shop are correct and detecting and rehardening the defective parts very much overbalances the cost of making the tests.

RECORDS OF HEAT TREATMENT

A card record of tools made in tool rooms will be found of great value. On these cards may be recorded the more important points concerning the various tools manufactured, such as the name of tool, blue print number, maker and grade of steel, temperature to which heated when hardening and time in furnace, quenching medium, whether tool was cooled in clear water, brine, oil, etc., drawback temperature and time in furnace or oil bath, scleroscope hardness and, last but not least, space should be provided in which to record the general behavior of the tools, a sample form of card being shown in Table I.

TABLE I. TYPICAL FORM OF TOOL RECORD

Tools. Record of Heat Treatment.

Article .....
Shop used in.....
Make of steel.....
Trade name or mark.....
Carbon .....
Harden at degrees F.....Quench in.....
Draw degree F.....Quench in.....
Scleroscope Hardness.....
Remarks .....
(Over)

Where a record of this nature is kept it may be consulted to show the entire history of the tool. As an illustration, take the case of staybolt taps. A lot made may wear too rapidly when in service. The card index covering the taps in question may be consulted and the probable cause of the defect determined. This may show a scleroscope hardness below 65, indicating that too high a heat was used when drawing the temper or other causes. If some of the lot of these taps are on hand that have not been used, they may be rehardened and drawn to the correct degree of hardness. If, after the second treatment, the taps hold up in a satisfactory manner it will be an indication that the correct hardness has been arrived at, which would then be a subject of record.

A record made of tools purchased, such as the name, date, maker, hardness, etc., that stand up well in service, is also of value for consultation when making similar tools. Take the case of the staybolt tap. If necessary to make these in an emergency or to recut them to a smaller size, the record of satisfactory taps will at once indicate the proper degree of hardness.

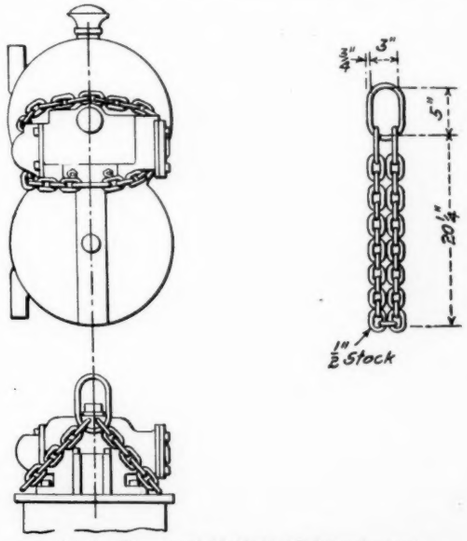
One class of tool largely used is the bridge reamer, required for steel car repairs. In order to properly stand up these must be of the proper hardness. If too hard excessive breakages will result, or if too soft rapid wear will follow. By recording the hardness of a number of these and noting results, a standard of hardness may be arrived at. Or if these are purchased it will be found advisable to test for hardness before placing them in use, and record the results. In the event that they have not the proper hardness the matter can be taken up with the manufacturers. During times of close competition it is advisable to let the manufacturers of tools know that the grade of tools is being watched, both for the good of the railway shop and also for the manufacturer, as the latter will generally welcome any criticism that may lead to the betterment of his product. Where it is possible to go back to the manufacturers with a statement of facts that satisfactory tools average, say, 70 on scleroscope reading and that the defective parts showed only 60, the statement will carry weight.

For ordinary tools, such as chisels, rail cutters, etc., the record of hardening and scleroscope is of value and well worth keeping. For the less frequently made tools, such as milling cutters, the records are of especial value. Where these tools have once been made and the data recorded, it is always possible to consult the record when a new tool of a similar nature is to be made. The previous method can then be followed if the tools were satisfactory, or modified in order to overcome any error. This record is of particular value for high speed steel cutters and various other tools made from this material on account of the high cost of the steel, and guards against the mistake often made of allowing too hard tools to go into service.

COMPRESSOR LIFTING CHAIN

BY A. G. JOHNSON
Mechanical Engineer, Duluth & Iron Range

In removing and applying the Westinghouse 8½-in. cross-compound air compresor, the chain shown in the illustration



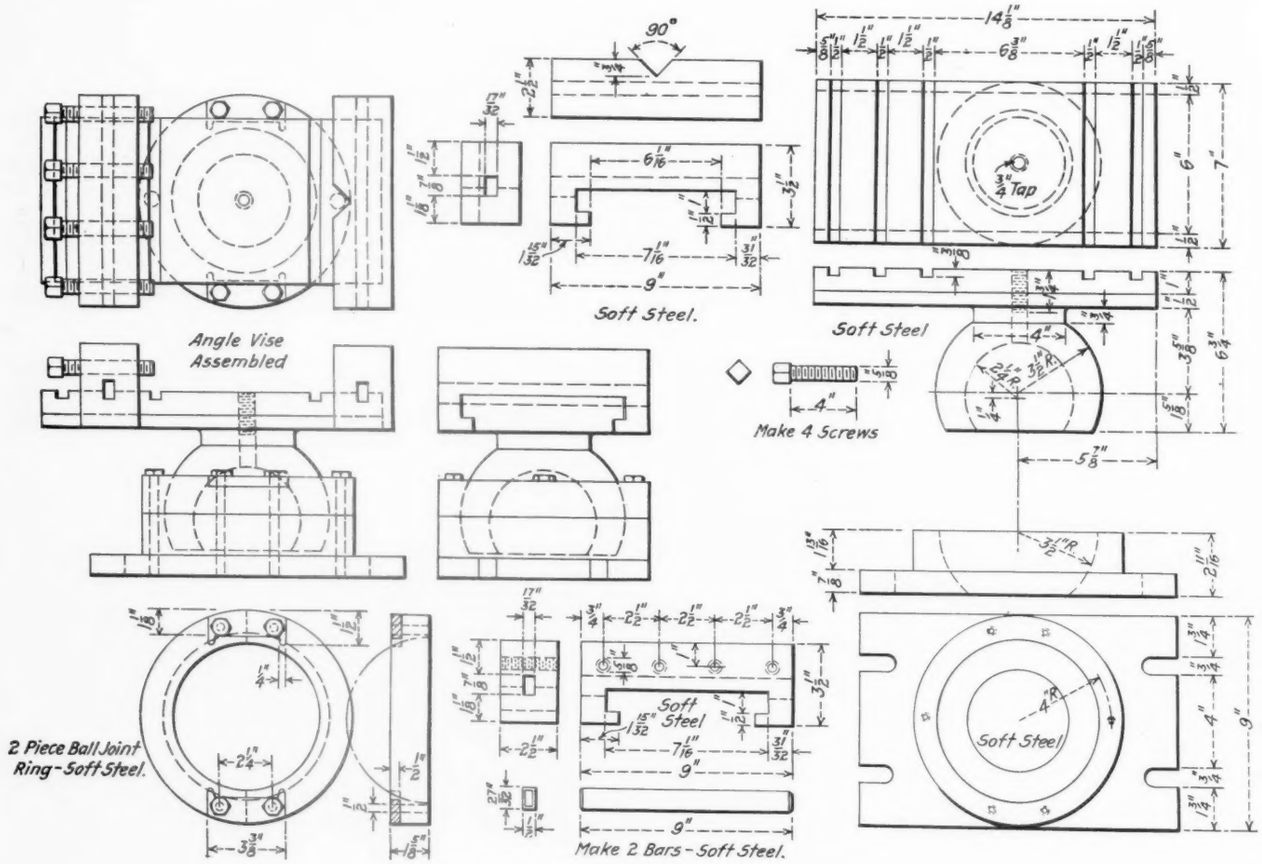
Chain Sling and Method of Attachment

will be found very convenient. The chain is made of ½-in. stock of the strength indicated, the ring at the top being made

of ¾-in. stock. In operation the chain is slipped over the top of the compressor around the valve chamber, as shown. The hook from the crane or chain block is then hooked into the large link, and when tightened up the chain is drawn around the valve chamber in such a way that it cannot slip. The compressor balances nicely, and it is comparatively easy to adjust the compressor so that the bracket bolts can be readily applied.

BALL JOINT VISE FOR DIE SINKING

Few railroad shops possess special die sinking equipment, and for that reason the vise shown in the accompanying drawing will be found especially useful. The adjustable jaws have a range to 9⅞ in. The ball can be swung through an angle of 45 deg. in any direction and is clamped by tightening the bolts holding the upper ring. The hand work involved in making dies can often be greatly reduced by the use of this vise, as the parts can be securely held at the proper angle to permit as many operations as possible to be performed on machines.



A Vise Which is Adjustable to Any Angle

RULES FOR AUTOGENOUS WELDING

The following rules adopted by the Committee on Standards for the purpose of preventing the use of autogenous welding for purposes for which it is not well adapted, have been sent to the regional directors by Frank McManamy, assistant director of the Division of Operation, with instructions to direct all roads to observe the rules in the construction or repair of locomotive boilers, so that any failures which may have been caused or contributed to by unrestricted or improper use of autogenous welding may be prevented.

The Committee on Standards, after carefully investigating the use of autogenous welding in connection with the construction and repair of locomotive boilers and fireboxes, has, in the interest of safety and efficiency, adopted the following rules:

1. Autogenous welding will not be permitted on any part of a locomotive boiler that is wholly in tension under working conditions; this to include arch or water bar tubes.

2. Staybolt or crown stay heads must not be built up or welded to the sheet.

3. Holes larger than 1½ in. in diameter when entirely closed by autogenous welding must have the welding properly stayed.

4. In new construction, welded seams in crown sheets will not be used where full size sheets are obtainable. This is not intended to prevent welding the crown sheet to other firebox sheets. Side sheet seams shall not be less than 12 in. below the highest point of the crown.

5. Only operators known to be competent will be assigned to firebox welding.

6. Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.

7. When repairing fireboxes, a number of small adjacent patches will not be applied, but the defective part of the sheet will be cut out and repaired with one patch.

8. The autogenous welding of defective main air reservoirs is not permitted.

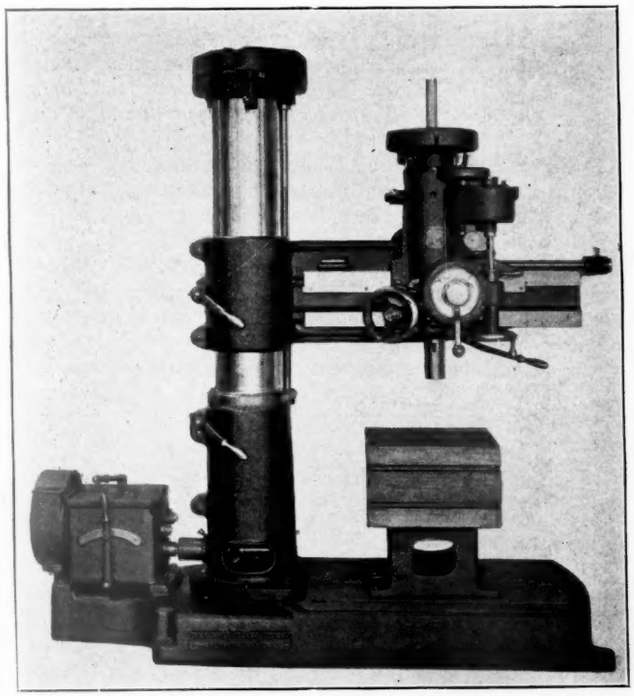
9. Welding rods must conform to the specifications issued by the Inspection and Test Section of the United States Railroad Administration for the various kinds of work for which they are prescribed, which specifications will be issued later.

NEW DEVICES

MORRIS RADIAL DRILL

A well proportioned radial drilling machine which up to its capacity is capable of pulling high speed drills at their maximum speed, has been placed on the market by the Morris Machine Tool Company, Cincinnati, Ohio. This machine is of rugged design, easy to operate, due to conveniently located control levers and can be used to good advantage in drilling, tapping, facing and counterboring operations.

The column construction does not vary greatly from standard

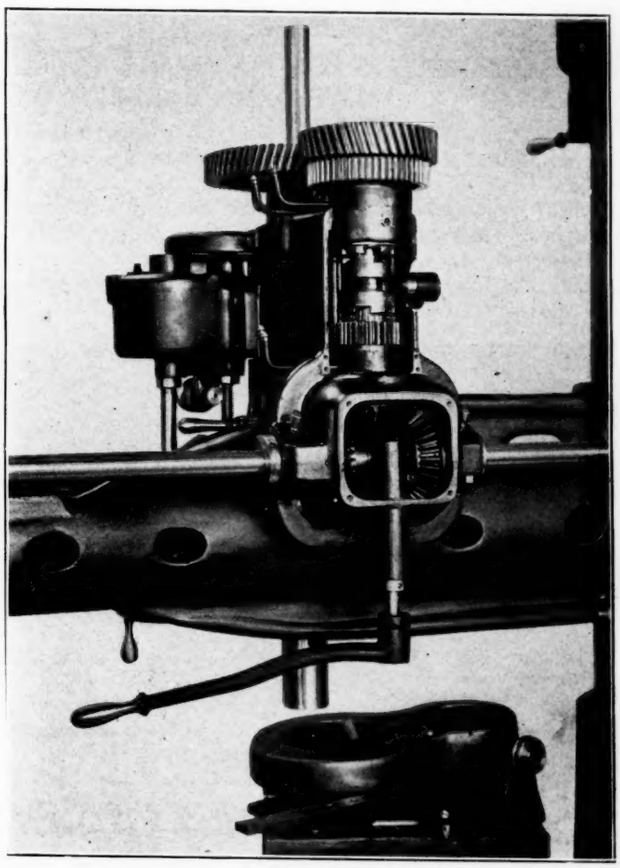


General View of Morris Radial Drill

practice, except that being supported on both a large ball bearing and a roller bearing, the arm can swing with exceptional ease. Suitable arrangements are made to rigidly clamp the column in the stump. The arm sliding on the column has a long bearing and can be clamped in any position by one lever, conveniently located. The arm can be raised and lowered by power through the lever at the top of the column. This lever has a tendency to throw itself into neutral when the tumbler gears are engaged, thus making it necessary for the operator to keep his hand on it when raising or lowering the arm. The tumbler gears are idle except when forced into mesh by the lever. The base, which is exceptionally deep and well ribbed, is provided with the usual T-slots and oil channel. The oil reservoir has an overflow partition to keep chips and dirt out of the pump.

The illustrations show a general view of the drill and a rear view of the head, which is heavily constructed. The head, being carefully balanced on the ways of the arm, travels freely and an extra wide tapered gib is provided to take up the wear. The clamping arrangement consists of two screws operated by one handle against the gib. The angle of the teeth of the helical spindle gears shown is great enough to insure more than one tooth meshing at a time, which avoids end thrust and eliminates the slight chatter usual with spur gears. The use of helical gears also insures a quiet, strong drive. A graduated dial depth gage, which trips the spindle speed at the desired depth, is another valuable feature of this new radial drill.

The back gears, mounted in a fully enclosed bracket, directly in back of the head, are made of 3½ per cent nickel steel, heat treated and hardened. Through these gears two speeds are obtained by a lever on the left hand side of the head. The reversing gears and friction clutches are mounted



Rear View of Head Showing Heavy Construction

in the same bracket, fully enclosed and running in oil. The lever controlling the reversing or tapping attachment is at the lower right hand side of the head, within easy reach of the operator.

The drill spindle is a hammered forging of high carbon steel, ground true to size and the end thrust is taken care of

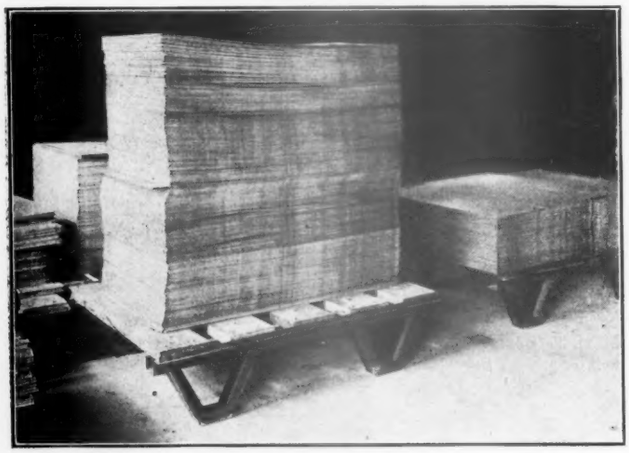
by a ball thrust bearing. Four feeds are obtained and marked on a dial in thousandths advance per revolution of the spindle. The feed can be automatically tripped at any depth within the traverse of the spindle. All the spur gears are hobbed and the bevel gears are carefully generated on a gear shaper.

The speed box is mounted on the base of the machine and six speeds are secured by means of the vertical lever on the front of the box and the friction lever on top. The latter controls the double friction clutch on the pulley shaft and when in neutral position stops every revolving part except the pulley shaft. All friction clutches in the feed box and the tapping attachment are of the expanding ring type. The rings are ground in an expanded position, thus insuring true contact when thrown in. They are of large diameter and wide face and are capable of a pulling power considerably greater than the capacity of the machine. The bearings throughout are made of bronze, arranged with oil chambers, the oil being drawn into the bearings by felt wipers. Arrangement is made for constant speed motor drive with the gear box, or variable speed motor drive through one pair of gears to the lower shaft. In the latter case a four-to-one variable speed motor would be necessary.

This radial drill is made in three sizes, 2½ ft., 3 ft., and 3½ ft. The maximum distance between the spindle and the base is 52⅜ in., and between the spindle and the table is 31⅜ in. The spindle traverse is 12 in., and spindle speeds vary from 20 to 400. A 3-hp. motor is required to drive the machine.

STEEL SUPPORTS FOR ELEVATING TRUCK PLATFORMS

The introduction of elevating trucks, now extensively employed around shops and storehouses, necessitates the use of special types of truck platforms. These have usually been made of wood and considerable trouble has been experienced, especially where heavy loads are handled, owing to the fact that the skid on which the platform is mounted frequently breaks, causing trouble in operation aside from the expense of repairs. To obviate this difficulty, the Lyon Metallic

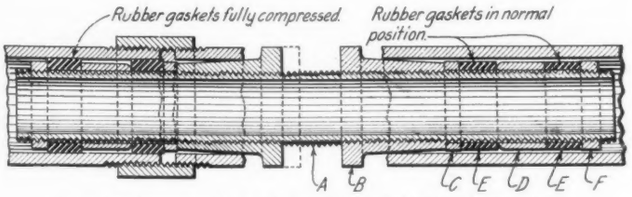


Steel Supported Truck Platform Loaded with Tin Plates to Capacity Greater than the Truck Can Lift to Show the Strength of Construction

Manufacturing Company, Aurora, Ill., has devised a steel skid leg. It consists of two welded feet which are in turn welded to a steel channel, this channel being provided with bolt holes spaced at suitable distances to provide for bolting on either a wooden or steel top. The skid legs can be used for platforms of any width depending on the length of the cross pieces. Another advantage of this device is that additional platforms may be carried in stock, knocked down, so that they take up very little space and yet are available when needed. The illustration shows a platform constructed with these skids, carrying a lead of seven tons. This is a greater weight than could be carried on the elevating truck but shows the great strength obtained with this method of construction.

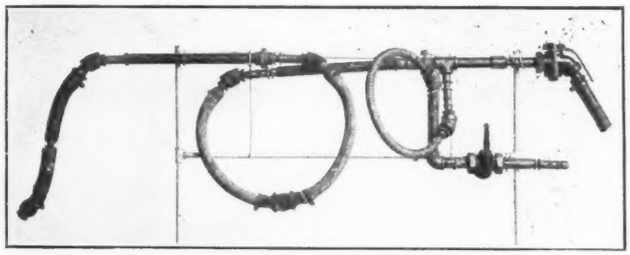
EMERGENCY CONNECTIONS FOR BRAKE PIPES

The attention of railroad men and supply manufacturers is constantly being given to improvement in the installation and repair of train pipes, with the result that many useful devices have been developed. One of these devices which has proved very efficient is shown in the illustrations. It is a method of coupling broken pipes which does away with the necessity of cutting threads that has been devised by J. L. Broschart and is now being manufactured by the Broschart



A Pipe Coupling Which Can Be Applied Without Tools

Threadless Pipe Coupling Company, Trenton, Mo. The object is to facilitate repairs in case of breakage of pipes forming part of the air brake or steam heating system either on locomotives or cars. In actual service as a part of the equipment carried on locomotives and cabooses, the threadless coupling has been found useful in preventing delays and engine failures, eliminating the necessity of switching cars to the rear of the train or cutting them out with the consequent expense of sending a mechanic to make repairs.



Method of Using the Emergency Connection in Making Temporary Repairs to Broken Brake Pipes

As shown in the illustration the coupling consists of a short section of pipe *A*, which carries two jam nuts *B*, and *D*, rubber gaskets *E*, and lock nuts *F*. In case a break occurs in the train line, the ends are separated about four inches enabling the coupling to be inserted in the pipe. By turning the jam nuts, the rubber gaskets are compressed and forced out against the walls of the pipe making an air tight connection. If the break occurs at the end of a pipe coupling or union, the tapered end of the jam nut is sufficiently long to allow the gasket to extend through into the pipe and make a tight joint. By the use of other fittings train lines can be connected even though the broken ends cannot be separated and in a similar manner angle cocks can be replaced and other air or steam pipes can be connected or plugged. The coupling can be applied without the use of any tools. It will withstand the standard trainline pressure and will not interfere with either service or emergency applications of the brakes.

HARTEND GENERAL SERVICE CAR, AND HART DOOR GEAR

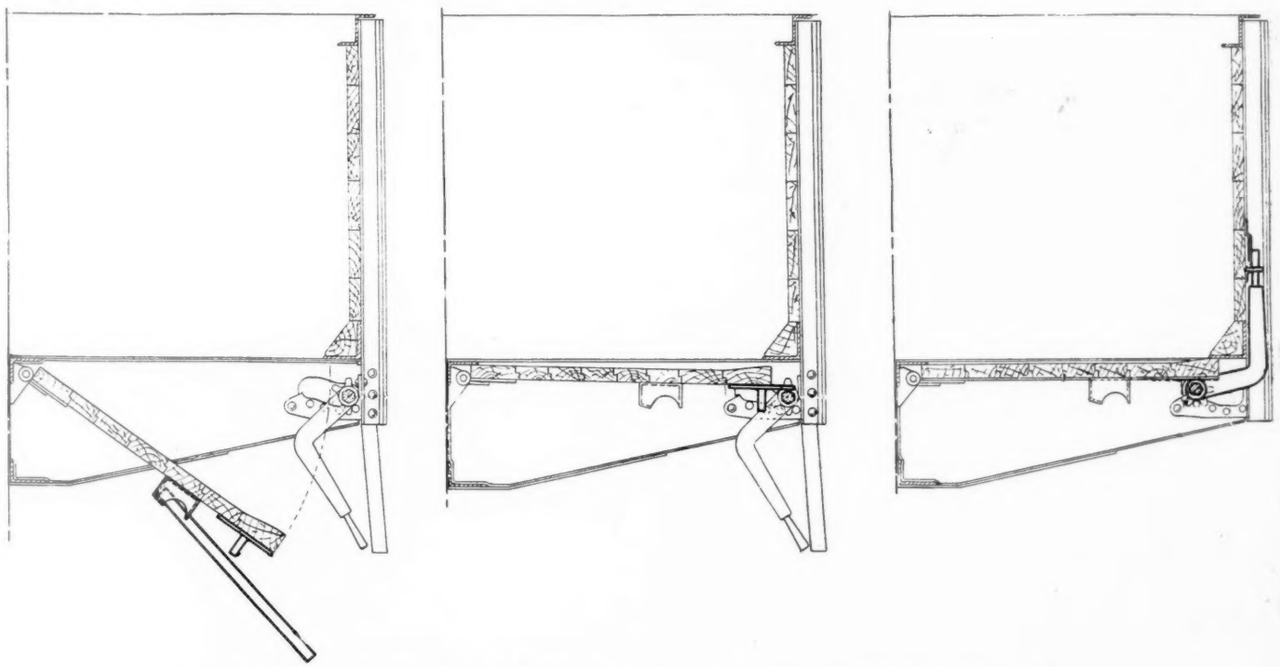
There are in service a large number of gondola cars fitted with drop doors through which more or less of the load may be dumped when the cars are handling bulky products such as coal or road building material. To be of the greatest value when handling such commodities, the drop doors should occupy the maximum possible proportion of the floor area in order that the least amount of shoveling may be necessary to clear the car. Such cars have been built with doors occupying the entire length of the floor on both sides of the center sill. In such designs, however, it has been difficult to secure sufficient structural strength at the corners to prevent distortion of the frame from the use of the push pole, so that the doors bind and are not easily operated.

In a number of designs this difficulty has resulted in the exclusion of drop doors and the use of a solid floor between the bolsters and end sills. Another difficulty which has discouraged the use of doors beyond the bolsters is the fact that, with these doors included, the operating mechanism must be placed at the end sill of the car at each corner. Here it is usually unprotected from abuse which frequently renders the mechanism inoperative.

With these two objections to the usual design of completely self-dumping gondola cars in mind, the National Dump Car Company, Chicago, has developed a design of drop bottom gondola known as the Hartend general service car. The purpose of this design is to provide a stiff end construction incorporating a solid floor plate from the end sill to the bolster at each end of the car, but arranged in such a manner that the load in this part of the car may be dumped at the side, as it would be through a drop door. How this has been accomplished is indicated in the illustration showing the end elevation and interior of the car. Between the bolster and end sill at either end the floor plates are sloped downwardly and outwardly from the center sill, in effect forming a hopper at each corner of the car. The outer sides of these hoppers are closed by swinging doors hinged at the top and easily closed and locked by hand. This design provides a rigid end construction, provides for the complete discharge of the load with practically no shoveling, and incidentally provides cubical capacity in the corner hoppers for from one and one-half to two tons additional load. A level floor is retained between the bolsters so that the suitability of the car for loading with lumber, rail, ties or other similar material is unaffected. As the hopper doors are readily operated directly by hand, this design permits the drop door shaft operating mechanism to be placed at the bolster where it is not exposed to damage from corner blows as it is when located at the ends of the car.

Another feature of recent development which is included in the construction of the car illustrated is a simple door looking and dumping mechanism, which may be applied to the drop doors of any general service gondola car of conventional design.

Generally speaking, door operating mechanism is more or less troublesome to maintain in satisfactory operating condition. Where chains are used to raise the doors they usually offer some obstruction to the movement of material in unloading and frequent readjustment is required to insure uniformity in closing all of the doors operated by one shaft. In the Hart door gear no attempt has been made to provide for the closing of the doors by the operating mechanism and all chains or other flexible connections between the doors and the shaft have been eliminated. Each door is closed by hand and temporarily latched, after which each group of doors is permanently locked as a unit. In unloading, a half turn of the permanent locking shaft releases the whole group.



Half Sections of the General Service Car Showing the Operation of the Hart Door Gear

For closing the doors each is provided on its under side with a metal socket and fulcrum so arranged that when the end of a short lifting bar is inserted in the socket the bar is held in a position convenient for raising the door. Mounted in short slots formed near the outer ends of the cross members of the underframe is a rolling shaft. When the doors are opened this shaft is moved to the outer ends of the slots, close to the side of the car so that it clears the outer edges of the doors. With the shaft in this position, as each door is raised by means of the lifting bar, the operator moves out a simple sliding latch on the under side of the door so that

its outer end rests upon the shaft, thus temporarily securing the door in the closed position. When all of the doors in each group have thus been secured they are permanently locked in the closed position by rolling the shaft inward through one-half revolution. For this purpose an operating lever is permanently attached to each shaft. In locking the doors this lever is turned up against the side of the car and locked in position by a sliding link, which is dropped over its end. As the shaft travels inward it engages the downwardly projecting lug or handle on the temporary latch and moves the latch back so that in dumping it offers no obstruction to the dropping of the door.

The drop doors are divided into two groups on each side of the car with the operating lever on each locking shaft located at the bolster end of the shaft. To dump all of the doors in each group the link is raised off the end of the

The Hartend Car Showing the Side Hoppers at the Ends

shaft operating lever, which is then turned outward and downward through approximately one-half revolution, thus rolling the shaft out from under the doors and allowing them to drop by gravity.

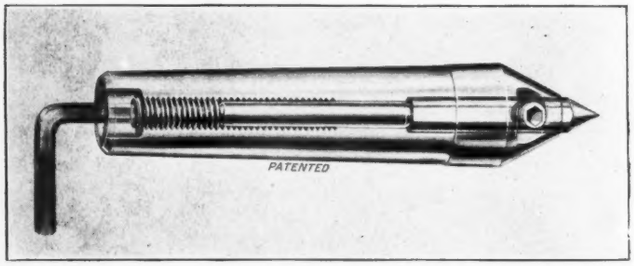
From an inspection of the drawings, it is evident that the rack on which the shaft is rolled is slightly elevated toward its inner end so that locking the shaft also tends to close the doors tightly against the bottom of the car. By closing each door individually any dirt or obstruction which might interfere with its proper closure is cleaned off so that the doors are easily closed and locked without being strained themselves or putting excessive strains on the locking mechanism. Should they be warped or sprung, however, the slope of the rack on which the shaft rolls affords a range of about 1 in., within which a sprung door causes the operator no difficulty in the closing and locking operations.

A sample car incorporating the end hopper and the Hart door operating mechanism has been in service several months handling soft coal. In this service it has proved to be self-clearing and incidentally has demonstrated its advantage in many instances, where cars are being unloaded into wagons on a team track, of making it possible to dump a small portion of the load at one corner to afford a place for shoveling without dumping an entire quarter of the load, as is usually necessary.

ADJUSTABLE POINT CENTER

An adjustable point center for lathes and grinding machines with several important advantages is shown in the accompanying illustration. The inserted point, made of specially hardened high speed steel, is held in place by a locking screw and can be adjusted for wear by means of the central pin and adjusting screw indicated. The body of the device is made of carbon steel with a hardened surface to prevent mutilation and a soft core for greater strength.

It is claimed that the use of this center in either a lathe or grinder will result in considerable saving over the old style of solid center. The high speed steel point will not readily overheat or burn, and when it does require grinding can be removed easily without moving the tailstock. The time required for grinding also is reduced because of the shorter angle to be ground and heavier feeds which can be



Robinson Adjustable Point Lathe and Grinding Machine Center

used. The grinding time has been reduced from 15 to 2 or 3 minutes.

Another advantage of an adjustable point center is that no allowance need be made for wear in the body. Therefore, the work being turned is brought closer to the tailstock and spindle, which reduces the chatter and protects the machine from extra wear. As the point is gradually worn, it is adjusted with the regulating screw, and when finally worn out the point alone may be scrapped instead of the whole lathe center.

This adjustable center is made by the Robinson Adjustable Center Company, Detroit, Mich., and can be used in the spindle or tailstock of any of the standard lathes or grinding machines.

Increased Wages Consumed 97 Per Cent of Increased Rates.—Increases in freight and passenger rates made during federal control amounted to $1,835,000,000 when applied to the traffic moved up to July 31, 1919, while the increases in wages applied to the number of employees and the hours or days worked in July, 1919, amounted to $1,774,800,000, or 97 per cent of the revenue from the increased rates, according to a statement compiled by the Interstate Commerce Commission at the request of Senator E. D. Smith of South Carolina.

ADJUSTABLE WALL RADIAL DRILL

The field for the use of wall column radial drills has been materially extended by a power elevating device incorporated in the radial drill, illustrated in Fig. 1, developed

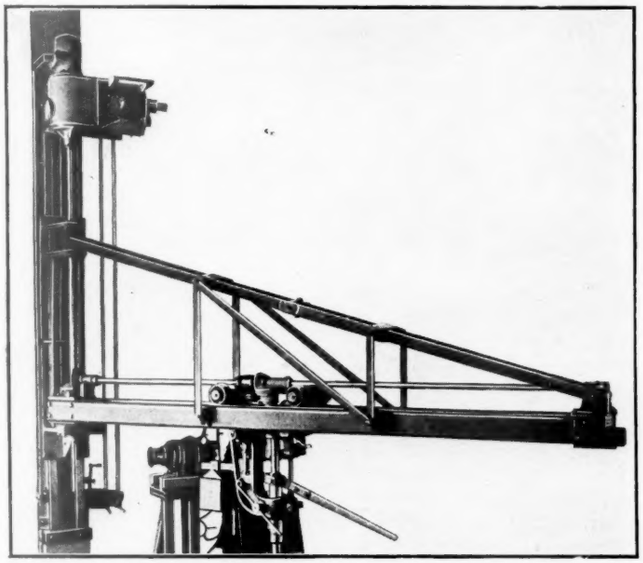


Fig. 1—Lynd-Farquhar Wall Column Radial Drill.

by the Lind-Farquhar Company, Boston, Mass. The power elevating mechanism increases the capacity, and makes the

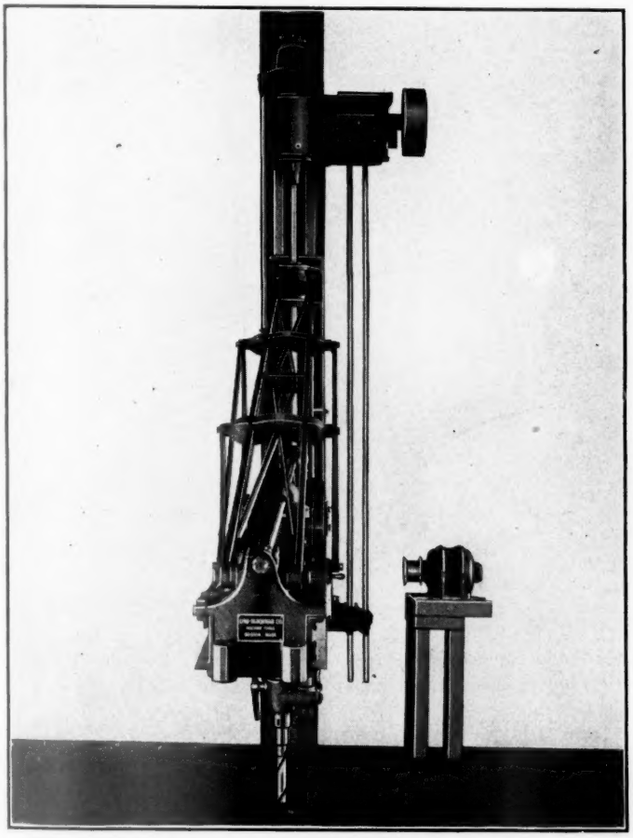


Fig. 2—View Showing Rigidity of Construction.

machine adaptable to a greater range of drilling operations. A four-foot vertical adjustment of the arm on the column is provided for and controlled by means of a vertical controller rod. An interfering device is provided which prevents the operator from raising or lowering the arm at high speeds, eliminating the chance of breakage from this cause. A friction coupling is also provided in the elevating mechanism, which will prevent breakage in case the operator neglects to lower the gib screws on the column.

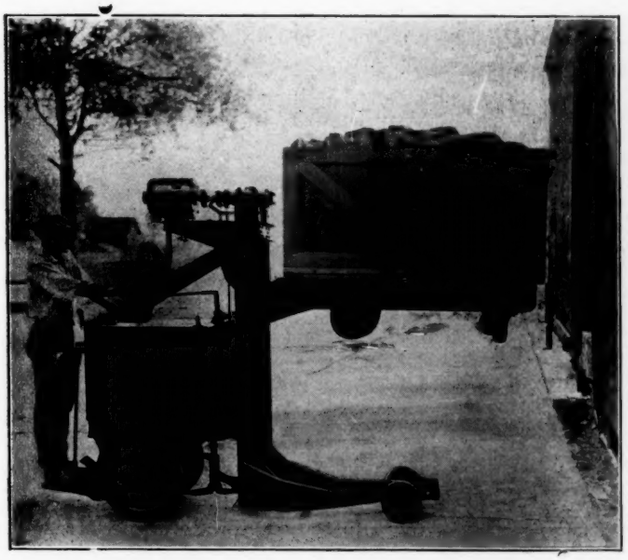
The rigid construction of this wall radial drill is shown in Fig. 2, which also indicates the motor drive and vertical controlling levers. In addition to the vertical braces, 1-in. by 3-in. tie rods are used, and in this way a very rigid and substantial structure is secured.

Four changes of spindle speed are provided through an improved design of gear box with a single pulley drive, which readily lends itself to a compact arrangement for motor driving, with a silent chain and sprocket when desired. These four speeds are controlled by conveniently located levers within easy reach of the operator.

TIER-LIFT ELEVATING TRUCK

An industrial truck, which with its own power elevates the loads to sufficient heights to put the material in box cars or stock rooms without rehandling, has been developed by the Lakewood Engineering Company, Cleveland, Ohio. This new truck performs the functions of a tiering machine as well as those of a load-carrying storage battery truck, and is called the Tier-Lift truck. It can elevate a two-ton load to a maximum height of 76 in., or to any intermediate height.

It has always been customary to transport material by means of hand trucks or some kind of power-driven truck which acted as a carrier only, but with this method men are required to transfer and lift the loads, and even when cranes are available considerable manual labor is required to handle the material. The use of this Tier-Lift truck, however releases the cranes from considerable work, gives a more flexible distribution system and reduces the waste of man-power



Elevating Truck Placing a Load in a Box Car

The height to which material can be piled economically is greatly increased and the storage capacity of a given floor doubled or tripled by the high lifting feature. The storing of material on skids to prevent rehandling in the storeroom is also made practical. Where the material is such that it can bear the weight of loads above, the loaded platforms can be piled on top of each other. The labor cost is thus reduced, material can be handled more quickly and the storage capacity of the floor space is greatly increased. With the

arrangement shown any loaded platform in the racks may be removed without disturbing the other loads, thus giving flexibility in the storeroom.

It is claimed that the four-wheel steer allows the truck to turn in a circle 92 in. in radius, thus permitting operation in narrow aisles or congested parts of the plant, and giving easy entrance into box cars, small storerooms, etc. The same form of drive is used in this truck as in the Lakewood tractor. There are three speeds forward and three speeds reverse. The controller handle is conveniently located for operation for travel in either direction. The lifting mechanism is operated by means of a specially designed controller with one speed in either direction. The lifting is done through two steel worm screws, a separate motor being used to supply the power.

The load platform is carried by a cantilever type support and the load is balanced over the carrying wheels. Ball bearings are used throughout and by a special design the friction losses in elevating and lowering the load platform are greatly reduced. It is claimed that the truck is easy to operate, and its use will result in a considerable saving of both time and labor.

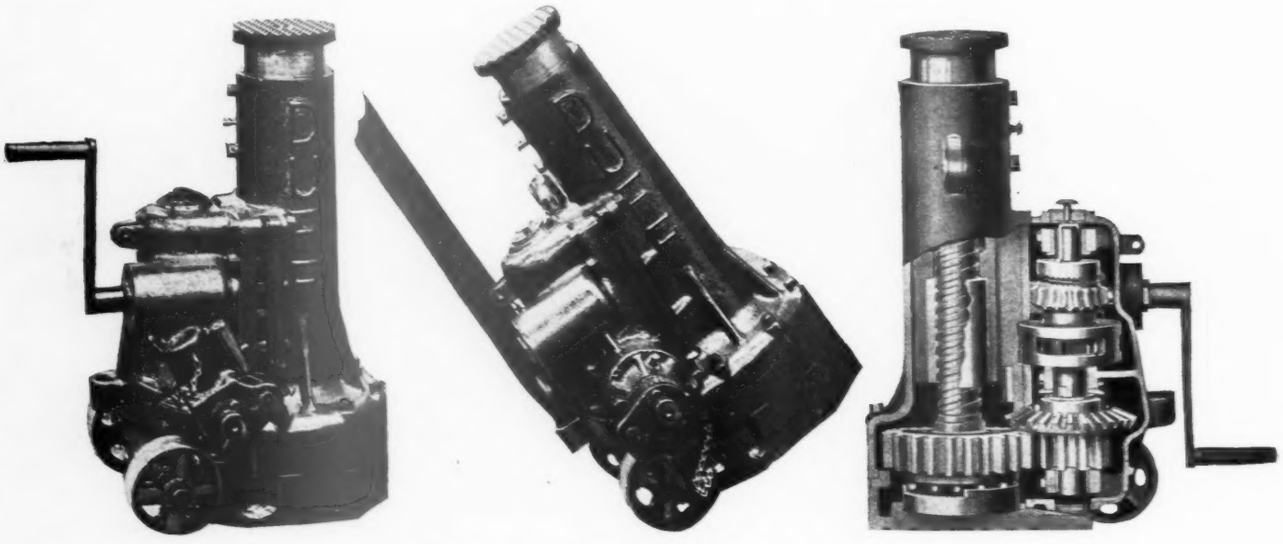
POWERFUL HIGH SPEED JACK

Several new features of construction are embodied in the latest design of high speed ball-bearing screw jack, built by the Duff Manufacturing Company, Pittsburgh, Pa. This 75-ton jack is particularly adapted for handling locomotives and other heavy railway equipment, because it is powerful, quick acting and can be moved easily. The distinguishing feature of this jack is the fact that the operating mechanism, instead of being located in the head, is placed in the base. As shown in the illustration, the weight is thus concentrated at the bottom instead of the top and the jack is not top-heavy. Another advantage is that the point at which the operating lever is pivoted does not rise with the load, which allows a full, powerful stroke regardless of the height of the load.

The Duff jack is unusually easy to move about, not only because the concentration of weight in the base gives a low center of gravity, but because, by inserting the operating lever in a special socket, the jack can be tipped over by one man and rolled on its own wheels wherever needed. The load on the jack is raised by means of a six-foot steel lever which operates a double-thread screw through a ratchet and gearing. The screw has a steep pitch, making the action exceptionally rapid for a jack of this capacity. The screw is made of special machinery steel, heat treated, and turns in a bronze nut of special composition. This combination of bronze and hard steel materially reduces friction.

Safety is assured by a positive clutch which holds the load at all times, preventing any possibility of its sinking or lowering. Another safety feature is the signal which is provided to indicate when the jack has reached its maximum height. For lowering the jack a crank handle is used and a few turns only are required, as the action is very rapid. Regardless of the speed with which the load may be descending, it may be safely checked at any point desired. The action is positive, so there is no possibility of the jack sticking during the lowering operation.

For the purpose of testing a Duff jack the rear end of an N-1-s type locomotive, weighing 215 tons, was raised, so that the rear wheels were off the track. It was estimated that the jack supported a weight of over 95 tons, showing that the 75-ton rating is conservative. This new type of high-speed ball-bearing screw jack is made in heights of 20, 24 and 26 in., capable of maximum lifts of 6, 10 and 12 in., respectively.



Duff 75-ton Jack Is Easy to Move and Rapid in Action.

HEATING RIVETS ELECTRICALLY.—In a paper read before the American Electro-Chemical Society, Chicago, G. M. Clark states that two American concerns have developed methods of heating rivets electrically. The American Car and Foundry Company employs a method whereby the rivet itself forms a short-circuit connection across the secondary of a transformer. A spring device holds the rivet in the desired position across the ends of the transformer while the operator holds the rivet with a pair of tongs and brings the spring holding device into operation by means of a foot lever. The consumption of electrical energy is about 20 units per 100 lb. of rivets, and the time taken to heat the rivet naturally varies with the size of the rivet. In another type of heater, employed by the Electric Furnace Company, a granulated carbon block forms the short-circuiting device across the transformed secondary, and in turn radiates heat to the rivets. The consumption of electrical energy for this type is about 18 units per 100 lb. of rivets.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 12,200 copies were printed; that of these 12,200 copies 11,064 were mailed to regular paid subscribers, 20 were provided for counter and news company sales, 216 were mailed to advertisers, 32 were mailed to employees and correspondents, and 868 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 12,200, an average of 12,200 copies a month.

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The Chicago, Milwaukee & St. Paul, aiming to reduce materially the losses on perishable foodstuffs, has created a new department, heated refrigerator service, in charge of O. M. Stevens. A new design of charcoal heater has been installed in 1,000 refrigerator cars in which are carried food products subject to injury by freezing.

It is reported that the Prussian Railway system is contemplating the use of internal combustion locomotives of the Deisel type to be used on proposed electrified lines, and it has already been decided that such locomotives will be built for experiment having a horsepower of 3,000. One of the purposes attributed to this work that in case of war these locomotives could be used over any tracks, even though electric power was not available.

A statement showing the number of women employed on railroads under federal control, received by the director general from the manager of the Woman's Service Section, shows that between April 1, 1919, and July 1, 1919, there was a decrease of 23.6 per cent in the number of women employed in roundhouse work, a decrease of 18.5 per cent in the number employed in shop work and a decrease of 15.1 per cent in the number employed in the car department.

The Philadelphia & Reading has received orders to turn over 14 of the 17 locomotives that had been built for the Russian government and which were stored at the roundhouse in Reading, to the Cumberland Valley Railroad. Thirty of these locomotives were originally received by the Philadelphia & Reading and were used on different parts of the system, but later a number were sent to the Reading shops, where they were stored after receiving a general overhauling.

Engineering Council has requested and the Director of the Census has ordered that the new census shall include a more detailed classification of engineers, so that technical engineers will be listed separately from non-technical engineers (stationary engineers, locomotive enginemen, etc.), enabling any one to ascertain readily the number of technical men in the United States and in each state. Technical engineers will be further subdivided between civil, mechanical, electrical and mining.

There is an unconfirmed report in Peking, China, that the Ministry of Communications has engaged the services of four foreign experts to assist in the standardization of rolling stock. France, England, Japan and America are said to be represented upon this group. For two years or more a Railway Technics Commission, composed of Chinese, has been working upon this subject. It is reported that this commission will submit to a convention of the mechanical officers of the lines, to be called next spring, a set of standards for goods wagons.

The Southern Pacific (Lines North of Ashland) has been awarded a banner by R. H. Aishton, regional director of the Northwestern region, for obtaining the best results of those roads employing over 2,000 men in the Northwestern region during the recent National Railroad Accident Prevention Drive. Although employing 4,676 men and operating 1,222 miles of road, the Southern Pacific (Lines North of Ashland) had no reportable casualties to employees during the entire period of the drive, while during the same two weeks of 1918 one employee was killed and 13 were injured.

The railway brotherhoods and other labor organizations, having received no encouragement from the Railroad Administration on their latest requests for increased wages, are working on a plan for reducing the cost of living through their own efforts by co-operative buying, production and distribution. Announcement has been made in Washington of the formation of the All-American Farmer-Labor Co-operative Commission, of which the officers of the railway unions are the officers to carry out the plan, and B. M. Jewell has issued a statement indicating the conclusion that increases in wages will not solve the problem, because they result in a vicious circle of increasing prices. The plans are to be perfected at another conference in Chicago, February 12.

The Engineering Experiment Station, Urbana, Ill., will have eight vacancies to fill in the Research Graduate Assistantships at the close of the current academic year. These assistantships, for each of which there is an annual stipend of $500 and freedom from all fees except the matriculation and diploma fees, are open to graduates of approved American and foreign universities and technical schools who are prepared to undertake graduate study in engineering, physics, or applied chemistry. An appointment is made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the

degree of Master of Science will be conferred. Not more than half of the time of a research garduate assistant is required in connection with the work of the department to which he is assigned, the remainder being available for graduate study. Additional information may be obtained by addressing The Director, Engineering Experiment Station, University of Illinois, Urbana, Ill.

The Tank Car Maintenance Problem

An article entitled The Tank Car Maintenance Problem, by Paul Bateman, appeared on page 647 of the November issue of the *Railway Mechanical Engineer*. This was an abstract of a paper presented before the Mid-Continent Section of the American Society of Mechanical Engineers and should have been credited to Mechanical Engineering.

American Firms Offer to Establish Belgian Car Works

According to a despatch from Brussels, copyright by the Chicago Tribune, the Belgian government has asked for offers for the building of railway rolling stock.

One offer has come from two American concerns, the despatch says, the Middletown Car Company and the American Car & Foundry Company, which combined efforts for the occasion. They offer to create on Belgian soil works for the construction of railway cars which would be installed on American lines. They would, however, employ exclusively Belgian labor; only the chiefs and engineers would be Americans.

After the delivery of the ordered carriages this model factory would be put, free of charge, at the disposal of the Belgian State. It would constitute ideal repair workshops with a staff of 2,500 men, which would have gone through a five months' "American training." The works would be connected by about eight miles of railroad.

The Middletown Car Company started in 1917 a model factory for the American army in France at La Rochelle which has an output capacity of 110 railway carriages a day. The parts for the cars would come from the United States and would be put together in the continental shops.

Commenting on the above despatch in New York, W. H. Woodin, president of the American Car & Foundry Company, said that such a plan had been considered while he was in Belgium recently, but the final action had not been taken.

Railroad Labor Leaders Object to Return of Roads and Anti-Strike Legislation

Officers of the 14 principal railroad labor organizations, including the four train service brotherhoods, at a conference with Samuel Gompers of the American Federation of Labor at Washington on December 29, adopted a declaration of principles expressing their dissatisfaction with the President's action in relinquishing control of the railroads as of March 1 and also their opposition to the anti-strike provisions of the Cummins bill, but saying nothing regarding the wage demands which most of them have pending before the Railroad Administration but which have been held in abeyreturned, but the labor leaders recently have been expressing greater concern over the proposed anti-strike law, which would take away much of their power to force wage increases by threatening to strike. The declaration adopted at the conference with Mr. Gompers says:

"That it is the sense of the conference that the control of the railroads should be exercised by the government of the United States for a period of not less than two years, that a proper test may be made as to government control.

"That such test has not been given a fair opportunity during the war times or since.

"This conference is opposed to legislation making strikes of workers unlawful. It is the sense of this conference that penalty clauses in pending legislation on railroads against workers ceasing their employment should be eliminated.

"That the conference favors the enactment of beneficial features of the bills which tend to establish better relations between employees and carriers.

"That the beneficial clauses should be extended to the sleeping car and Pullman Company employees."

MEETINGS AND CONVENTIONS

American Society for Testing Materials.—The annual meeting of this association will be held at the New Monterey hotel, Asbury Park, N. J., beginning on Monday, June 21, 1920. This is a departure from the precedent of long standing of holding the annual meeting at Atlantic City.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations:

Air-Brake Association.—F. M. Nellis, Room 3014, 163 Broadway, New York City.

American Railroad Association, Section III.—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—O. E. Schlink, 435 W. Fifth St., Peru, Ind.

American Railway Tool Foremen's Association.—R. D. Fletcher, Belt Railway, Chicago.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, June 21, 1920, New Monterey Hotel, Asbury Park, N. J.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York.

American Steel Treaters' Society.—Arthur G. Henry, Illinois Tool Works, Chicago.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.

Car Foremen's Association of Chicago.—Aaron Kline, 841 Laylor Ave., Chicago. Meetings second Monday in month, except June, July and August, Hotel Morrison, Chicago.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, secretary, Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.

Chief Interchange Car Inspectors' and Car Foremen's Association.—H. J. Smith, D. L. & W., Scranton, Pa.

International Railroad Master Blacksmiths' Association.—A. L. Woodworth, C. H. & D., Lima, Ohio

International Railway Fuel Association.—J. G. Crawford, 542 W. Jackson Blvd., Chicago.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabasha Ave., Winona, Minn.

Master Boilermakers' Association.—Harry D. Vought, 95 Liberty St., New York. Convention May 25-28, Curtis Hotel, Minneapolis, Minn.

Master Car and Locomotive Painters' Association of U. S. and Canada.—A. P. Dane, B. & M., Reading, Mass.

Niagara Frontier Car Men's Association.—George A. J. Hochgrebe, 623 Brisbane Bldg., Buffalo, N. Y. Meetings, third Wednesday in month, Statler Hotel, Buffalo, N. Y.

Railway Storekeepers' Association.—J. P. Murphy, Box C, Collinwood, Ohio.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. R. R., Cleveland, Ohio.

RAILROAD CLUB MEETINGS

Club	Next Meeting	Title of Paper	Author	Secretary	Address
Canadian	Jan. 13, 1919	Graphic Production Control	E. T. Spidy	W. A. Booth	131 Charron St., Montreal, Que.
Central	Jan. 9, 1919	Continuation of discussion on November paper, Locomotive Operations, Annual reports and installation of new officers.		H. D. Vought	95 Liberty St., New York.
Cincinnati				H. Boutet	101 Carew Building, Cincinnati, O.
New England	Jan. 13, 1919	Steel Specifications	F. A. Weymouth	W. E. Cade, Jr.	683 Atlantic Ave., Boston, Mass.
New York	Jan. 15, 1919	Dinner; Addresses by Hon. E. C. Stokes and Hon. Job E. Hedges		H. D. Vought	95 Liberty St., New York.
Pittsburgh	Jan. 22, 1919	Express Transportation	D. N. Gibson	J. D. Conway	515 Grandview Ave., Pittsburgh, Pa.
St. Louis	Jan. 16, 1919	Idealism in Business	Rev. Z. B. T. Phillips	B. W. Frauenthal	Union Station, St. Louis, Mo.
Western	Jan. 19, 1919	Preparation of Locomotives at Engine houses and Shops and Its Relation to Fuel Economy	L. R. Pyle	J. M. Byrne	916 West 78th St., Chicago.

PERSONAL MENTION

GENERAL

P. G. WINTER has been appointed mechanical valuation engineer of the Chicago, Milwaukee & St. Paul at Chicago, succeeding W. F. Lynaugh, assigned to other duties.

R. G. BENNETT, master mechanic of the Pennsylvania at Pittsburgh, Pa., has been appointed superintendent of motive power of the Central division, with headquarters at Williamsport, Pa., succeeding E. W. Smith. Mr. Bennett was born at Brighton, England, on March 31, 1882. He entered the service of the Pennsylvania Railroad in 1900 as a machinist apprentice in the Erie, Pa., shops, completing his apprenticeship at the Renovo, Pa., shops four years later. He graduated from Purdue University in 1908 as a bachelor of science in mechanical engineering and in 1915 he was given the degree of mechanical engineer. While attending college, he worked during the summer months as a machinist, draftsman and inspector and in November, 1908, was appointed motive power inspector of the Monongahela division. He was later transferred to the maintenance of way department and then to the test department at Altoona. In May, 1916, he went to Chambersburg, Pa., as assistant master mechanic of the Cumberland Valley Railroad, but returned to the Pennsylvania Railroad in February, 1917, as assistant engineer of motive power of the Central division and later in that year he was appointed master mechanic at Pittsburgh.

R. G. Bennett

F. S. DEVENY, assistant road foreman of engines of the Baltimore & Ohio, Chicago Terminal, has been promoted to the position of trainmaster at Chicago, succeeding J. W. Dacy, deceased.

LUKE J. GALLAGHER, locomotive engineman on the Northern Pacific, has been promoted to the position of road foreman of engines of the Rocky Mountain division, with headquarters at Missoula, Mont., succeeding H. E. Day, who has been granted leave of absence.

J. A. MARSHALL, road foreman of engines of the Northern Pacific, at Duluth, Minn., has been appointed acting master mechanic of the Lake Superior division, with the same headquarters, succeeding J. E. Goodman, who has been given a temporary leave of absence.

S. E. MUELLER, general foreman in the locomotive department of the Chicago, Rock Island & Pacific, at Cedar Rapids, Iowa, has been promoted to master mechanic of the Dakota division, at Estherville, Iowa, succeeding R. J. McQuade, who has resigned.

F. S. ROBBINS has been appointed master mechanic of the Pennsylvania at Pittsburgh, Pa., succeeding R. G. Bennett.

G. E. PASSAGE, traveling engineer of the Chicago, Milwaukee & St. Paul, with headquarters at Chicago, has been appointed trainmaster of the Illinois division at Savannah, Ill.

E. O. SMITH, master mechanic on the St. Louis & Hannibal, with headquarters at Hannibal, Mo., has been appointed to the newly-created position of master mechanic on the Louisiana & North West, with office at Homer, La.

CLARENCE E. TROTTER, whose appointment as master mechanic of the Lake Erie & Western, with headquarters at Lima, Ohio, was announced in these columns last month, was born on March 29, 1890, at Plainfield, Ind. He was graduated as a mechanical engineer from Purdue University in 1912. He then served a special apprenticeship with the Cleveland, Cincinnati, Chicago & St. Louis and during this time spent eleven months on the Lake Erie & Western investigating the merits of different boiler compounds, with respect to the cost of locomotive maintenance. On completing the apprenticeship course he was sent to the Mexican border as an inspector of material and during the war served overseas as a first lieutenant and a captain in the Forty-second division. In June, 1919, he was appointed assistant enginehouse foreman of the Cleveland, Cincinnati, Chicago & St. Louis, at Brightwood (Indianapolis), Ind., and for a time was acting night enginehouse foreman. He was recently appointed master mechanic of the Lake Erie & Western, the Fort Wayne, Cincinnati & Louisville and the Northern Ohio, as previously noted.

N. P. WHITE, roundhouse foreman of the Northern Pacific at Duluth, Minn., has been promoted to master mechanic of the Minnesota division at Staples, Minn., succeeding William Radke, deceased.

C. H. WILCKEN has been appointed traveling engineer and trainmaster of the Denver & Rio Grande, with headquarters at Helper, Utah, succeeding G. W. Bourne, transferred.

SHOP AND ENGINEHOUSE

JOHN B. DAVIS has been appointed night roundhouse foreman of the Erie at Meadville, Pa., succeeding C. Kinney, transferred.

F. C. MOELLER, roundhouse foreman of the Chicago, Rock Island & Pacific, at Blue Island, Ill., has been promoted to general foreman in the locomotive department at Cedar Rapids, Iowa, succeeding S. C. Mueller.

ALDEN MORGAN has been appointed erecting shop foreman of the Erie at Huntington, Ind., succeeding P. F. Myers, resigned.

PURCHASING AND STOREKEEPING

F. E. JOHNSON, storekeeper of the Baltimore & Ohio at Mt. Clare, Baltimore, Md., has been appointed assistant general storekeeper at Baltimore.

TOM MOORE, general storekeeper of the Virginian at Princeton, W. Va., has been appointed purchasing agent, succeeding A. B. Lacy, resigned. D. C. King succeeds Mr. Moore.

T. H. RYAN, local purchasing agent at New Orleans, La., of the Vicksburg & Alabama, has been appointed purchasing agent of that road and of the Louisiana & Mississippi Transfer and the Vicksburg, Shreveport & Pacific.

H. SHOEMAKER, district storekeeper of the Northwest District of the Baltimore & Ohio, with headquarters at Cleveland, Ohio, has been appointed storekeeper at Mt. Clare, Baltimore, Md., succeeding F. E. Johnson.

OBITUARY

ALFRED E. CORBETT, locomotive foreman of the Canadian National Railways at St. John, N. B., was accidentally killed while at work on January 16. He was 34 years old and had been in the employ of the Canadian National for about eight years.

SUPPLY TRADE NOTES

The American Car & Foundry Company has begun to purchase approximately $200,000 worth of machine tool equipment.

H. H. Hendricks, formerly connected with the Ryan Car Company, Chicago, has been appointed a salesman for the Camel Company, Chicago.

John W. Fogg, sales representative of the Boss Nut Company, Chicago, with office in that city, has been promoted to railroad sales manager, with the same headquarters.

Irving H. Jones of Chicago, has become associated with the machinery department of Joseph T. Ryerson & Son, and will specialize in sales engineering work for that company.

The Van Dorn Girder Plate Company, manufacturer of railway car appliances, has removed its general offices from 2325 South Paulina street, Chicago, to 608 South Dearborn street.

C. A. Pinyerd, supervisor in the Chicago office of the Safety Car Heating & Lighting Company, New York, has been appointed sales representative, with the same headquarters.

The Cleveland Twist Drill Company has purchased a 17-acre factory site on the eastern outskirts of Cleveland, Ohio, to provide for factory enlargements which it expects to make in the near future.

J. F. Comee, formerly associated with the Camel Company as representative at Chicago, has been appointed manager of sales, with headquarters at Chicago, for the Hutchins Car Roofing Company, Detroit, Mich.

William A. Benson, formerly associated with the Adams & Westlake Company, Chicago, has been appointed assistant manager of sales in the Chicago district for the Hanna Locomotive Stoker Company, Cincinnati, Ohio.

Hal R. Stafford, who has been chief engineer of the Franklin Railway Supply Company, Inc., since this company took over the Economy Devices Corporation, died at his home in Plainfield, N. J., on December 9.

C. R. Ellicott, assistant eastern manager at New York of the Westinghouse Air Brake Company, Pittsburgh, Pa., has been promoted to eastern manager, with headquarters at New York, succeeding Joseph R. Elliott, retired.

E. A. Woodworth, secretary of the Committee on Mechanical Standards of the United States Railroad Administration, has resigned to become special representative for the Chicago Pneumatic Tool Company, with office at Chicago.

E. E. Griest, formerly master mechanic of the Fort Wayne (Ind.) shops of the Pennsylvania Lines West, has been appointed general superintendent of the Chicago Railway Equipment Company, with headquarters at Chicago.

R. B. Jones and E. E. Hart, both formerly of the Dale-Brewster Machinery Company, Inc., Chicago, have resigned and organized the Industrial & Railroad Supply Company, with headquarters at 114 North Desplaines street, Chicago.

Edward D. Kilburn, who since March 16, 1917, has been New York district manager of the Westinghouse Electric & Manufacturing Company, was recently elected vice-president and general manager of the Westinghouse Electric International Company, New York, which was formed in the spring of 1919 to succeed the Westinghouse Electric Export Company.

The American Steam Conveyor Corporation, Chicago, announces that the Atlas Machinery & Supply Company, 1416 Syndicate Trust building, St. Louis, Mo., is now handling the sale of the American steam ash conveyor in the St. Louis territory.

The Schaefer Equipment Company, Pittsburgh, Pa., manufacturers of railway materials, has recently completed arrangements with the International Equipment Company, Ltd., Montreal, Quebec, to handle its manufactures and sales in Canada.

A. P. Van Schaick, special representative at Chicago of the American Chain Company, Inc., Bridgeport, Conn., has been appointed assistant general sales manager of the company, with headquarters at the Grand Central Terminal New York.

The Duntley-Dayton Company, Chicago, manufacturers of pneumatic and electric tools, has changed its name to The Duntley Pneumatic Tool Company. There is no change of officers, the change in corporate title having been for business reasons.

The St. Louis Machine Tool Company is building an addition to its plant at St. Louis, Mo., which will add about 13,000 sq. ft. to the floor space and practically double the capacity for the manufacture of grinding, polishing and tapping machines.

Fred C. Dunham, formerly assistant to the president of the National Railway Appliance Company, has been elected vice-president of the Hutchins Car Roofing Company, Detroit, Mich. Mr. Dunham's headquarters are 103 Park avenue, New York.

Charles Nourse, until recently in charge of the engineering department of the Heald Machine Company, Worcester, Mass., has severed his relations with that company to accept a position with the Lombard Machine Company, Worcester. Victor Bergstrom succeeds him.

The General American Tank Car Company, Chicago, will build a plant on the Mississippi river, a short distance above New Orleans, La., to cost $1,000,000. The new plant will include a machine shop and steel foundry for the manufacture of tank cars, gondolas, flat cars, etc.

The Mid-Continent Equipment & Machinery Company has been organized at St. Louis, Mo., to deal in railway supplies. F. W. Glauser is president, R. H. Wilson vice-president, and J. B. Fidler secretary-treasurer. The offices of the new company will be in the Security building.

The Firth-Sterling Steel Company, McKeesport, Pa., will move its New England headquarters from 35 Oliver street, Boston, Mass., and after February 1 will occupy a new warehouse at 85-91 West First street, South Boston, where complete stocks of Blue Chip high-speed steel and other Firth-Sterling tool and die steels will be carried.

D. L. Eubank has been appointed district manager in charge of the Cincinnati office of the Galena-Signal Oil Company. Mr. Eubank was born November 24, 1869, and was in the employ of the Chesapeake & Ohio from September, 1889, to February, 1911, as locomotive fireman, engineman and road foreman of engines. In February, 1911, Mr. Eubank accepted a position as mechanical expert with the Galena-Signal Oil Company.

Albert Schmid, consulting engineer for the Westinghouse Electric & Manufacturing Company, died in New York on December 31, 1919. Mr. Schmid was closely identified with the early development of electrical machinery in the United States and was also prominent in the electrical world of France, Switzerland, Italy and Great Britain. At the time

of his death he also represented the Westinghouse Lamp Company and had general supervision of its interests abroad.

Frank O. Wells, president of the Greenfield Tap & Die Corporation, and one of the prominent figures in the screw thread industry in the United States, has sold his entire holdings to Frederick H. Payne, vice-president. Mr. Wells retires as president and member of the board of directors, but will remain with the corporation in an advisory capacity. Mr. Payne has been elected president and F. G. Echols, vice-president and general manager, has been elected a director of the corporation.

The Gustin-Bacon Manufacturing Company, Kansas City, Mo., has purchased all machinery and equipment formerly used by the Emery Pneumatic Lubricant Company of St. Louis, Mo., and has also acquired the exclusive rights to the manufacture and sale of the Emery brake cylinder lubricant. E. A. Emery, the originator of the Emery brake cylinder lubricant formula, has become associated with the Gustin-Bacon Manufacturing Company and has direct charge of the manufacture of this product.

Owing to the rapidly increasing use of the American staybolt and the reduced body staybolts by the railroads and industrials of this country, Benson & Co., with general offices at 50 Church street, New York, has been organized to promote the sales and service of the American Flexible Bolt Company products. R. W. Benson, general sales manager, is president of the new company. Both companies will maintain engineering service organizations to study locomotive boiler staybolt problems and aid in their solution.

Arthur W. Wheatley, who was elected president of Armstrong Whitworth (of Canada), Ltd., in November of last year, is now in full control and direction of the Longuiel works. The works have, since their inception, been engaged in the manufacture of tool steels, small tools, railway tires, etc., and with the cessation of hostilities the policy and energies of the firm were directed toward the further development of their products, especially of railway material, for which there is a heavy demand. It is proposed also to develop the manufacture of all-steel wheels for rolling stock.

L. R. Custer, formerly development engineer for the Midvale Steel & Ordnance Company, has been elected a vice-president of the Cambria Steel Company. He was born in Altoona in 1873, and graduated from Cornell University in 1902. His first work was as a machinist for the Pennsylvania Railroad. He later was in the employ of the Baldwin Locomotive Works, and then served as a draftsman for the Jones & Laughlin Steel Company, Pittsburgh. He entered the service of the Homestead Steel Company as a construction foreman and in 1914 was made superintendent of the armor plate department. During the early part of the war he developed the ordnance department of that company. Shortly before the close of the war he left the Homestead Company to go with the Midvale Company.

Major J. L. Hays has been appointed electrical engineer of the Stone Franklin Company, with office at 18 East Forty-first street, New York. Major Hays has a wide experience in electrical engineering problems, particularly as regards electric car lighting. He was graduated from Lehigh University in 1909, with the degree of electrical engineer. Upon graduation he joined the electrical department staff of the Baltimore & Ohio and worked successively as mechanic, draftsman, inspector, general foreman and assistant engineer. From the Baltimore & Ohio he went to the Seaboard Air Line as electrical engineer, and when war was declared with Germany he was commissioned as major in the Quartermaster Corps and was the officer in charge of the electrical section of the engineering branch, responsible for electrical construction for the army in the United States.

The business and property of the O. S. Walker Company, Worcester, Mass., manufacturers of grinding machines and magnetic chucks, has been sold by Oakley S. Walker to a group of men prominently connected with the machine tool and supply business, and the reorganization of the company has been completed. The name of the company will remain unchanged and the new officers are: president, W. B. McSimmon, Boston; vice-president, J. H. Drury, Athol; general manager, secretary and treasurer, Clayton O. Smith. The new ownership brings with it increased financial resources, which will make possible future development and increase of the business. The company manufactures grinding machines of various types and magnetic chucks used in holding iron and steel parts while they are being ground or machined.

John C. Barber, founder and president of the Standard Car Truck Company, Chicago, and inventor of over 75 railway truck appliances, died in Los Angeles, Cal., on December 27, 1919. He was the inventor of a device for limited lateral play in railway trucks which has been applied to about 20 per cent of the freight cars of the country. Mr. Barber was born in St. Lawrence county, New York, on December 12, 1844. In September, 1861, he enlisted in a Wisconsin regiment and served throughout the Civil war. In 1865 he began his railway career with the Chicago & North Western in its locomotive and car-building department at Fond du Lac, Wis., filling various positions there for six years. He then became connected with the mechanical department of the Northern Pacific shops at St. Paul, Minn., and in 1873 was appointed superintendent of the car department of the Missouri, Kansas & Texas, with headquarters at Sedalia, Mo. From 1883 to 1885 he was superintendent of the Rio Grande division of the Texas & Pacific, with office at Fort Worth, Tex. From the latter date until he resigned to market his inventions, in 1896, he was in charge of the car department of the Northern Pacific at St. Paul, Minn. It was while serving in this latter capacity that he perfected his invention for lateral roller motion trucks. In 1898 he organized the Standard Car Truck Company, and of this organization he retained the presidency until his death.

J. C. Barber

Jenkins Brothers in the near future will increase the manufacturing facilities for the production of Jenkins valves by the establishment of a plant in Bridgeport, Conn. The manufacture of Jenkins disks, sheet packings, pump valves and other mechanical rubber goods will be continued at Elizabeth, N. J. Alterations and additions to the brass valve department of Jenkins Brothers, Ltd., Montreal, the Canadian branch, have recently been completed, and a new iron valve foundry building 80 ft. wide by 192 ft. long is now in course of construction. This plant supplies Canada and foreign countries, while the Bridgeport plant will manufacture valves for use in the United States and insular possessions.

Lieut. Vernon S. Henry who served prior to the war, in an engineering capacity with the Safety Car Heating & Lighting Company, New York, has re-entered the service of

that company and is now connected with the Philadelphia office as sales representative. Lieutenant Henry is a graduate of Stevens Institute of Technology and at the outbreak of the war attended the first training camp at Fort Myer, Va., and received his commission as first lieutenant in August, 1917. He went to France the following November and was in charge of automatic rifles in the A. E. F., remaining there until May, 1918. He then returned to the United States to assist in the production of machine gun tripods, model 1919, and for his development in this work he afterwards received a citation for meritorious and conspicuous service. In 1918 he returned to France and was in charge of the development of machine gun and anti-aircraft material until discharged from the service in February, 1919.

The Locomotive Terminal Equipment Association, Inc., has recently been organized by a group of manufacturers and dealers in equipment for use in locomotive terminals, for the purpose of studying the needs for improvement in locomotive terminals in order to secure quicker handling, repairing and turning of locomotives. In the distribution of such data as is developed from the surveys made or from other sources, a policy of impartiality is to be followed and no special advantage is to accrue to any individual firm or corporation that may be a member of the association. The officers are: President, William R. Toppan, manager railroad department, William Graver Tank Works; vice-president and secretary, Bruce V. Crandall; treasurer, John S. Maurer, secretary and treasurer, National Boiler Washing Company; general counsel, Frank J. Loesch. The board of directors consists of the following seven members: William R. Toppan, Bruce V. Crandall, Spencer Otis, president, National Boiler Washing Company; William Robertson, William Robertson & Co.; Frank W. Miller, president, F. W. Miller Heating Company; Robert A. Ogle, president, Ogle Construction Company, and Norman S. Lawrence, vice-president and assistant sales manager, Whiting Foundry Equipment Company. The association has headquarters at the office of the secretary, room 1824, Lytton building, Chicago.

Dr. M. E. Pennington has joined the staff of the American Balsa Company, Inc., New York, manufacturers of Balsa wood products, including insulation material. She will be in charge of research and development work. Dr. Pennington graduated from the University of Pennsylvania where she specialized in chemistry and received the degree of P.D She had charge of the chemical department of Women's Medical College of Pennsylvania and later of the City Bacteriological Laboratory of the Department of Health and Charities of the City of Philadelphia; she then established her own clinical laboratory, making a specialty of doing scientific research work in connection with medical research work of practicing physicians. Since 1905 she has been employed by the U. S. Department of Agriculture, having entered the service on part time, doing special research work, and later took up the preservation of foods by better handling methods, especially the application of refrigeration to all phases of the distribution of foodstuffs. Dr Pennington gradually gave up her various other interests and has devoted herself entirely to that line of work under the auspices of the Department of Agriculture since 1907, when the Research Laboratory formally was established as an organization of the department. Dr. Pennington is the author of a number of articles which have appeared in the technical press and elsewhere, dealing, with chemistry, bacteriology and botany. Since her connection with the Department of Agriculture a number of articles by Dr. Pennington on the preservation of foodstuffs by low temperatures, the effect of better methods of handling perishables, also on refrigerator cars, have appeared in the *Railway Mechanical Engineer*.

CATALOGUES

Pipe Cutting and Threading Tools.—A new catalogue, No. 12, of Beaver cutting and threading tools for pipe has been published by the Borden Company, Warren, Ohio. It contains list prices and data for complete tools and extra parts and a large number of illustrations.

Portable Welding Outfits.—Three types of trucks for transporting portable oxy-acetylene and oxy-hydrogen welding and cutting equipment manufactured by the Davis-Bournonville Company, Jersey City, N. J., are described and illustrated in an eight-page pamphlet. One of these is a cabinet truck which provides permanent mountings for the regulators and gages within a steel locker, which also affords space for the torches, hose, accessories and supplies. The other two are open trucks, one having large wheels especially fitted for traveling on rough ground and the other having small wheels, designed for use on floors, pavements and level ground.

Casehardening Materials.—Bell & Gossett Company, Chicago, Ill., briefly describe several products manufactured by them for use in casehardening, in a pamphlet entitled Casehardening Materials. These specialties include a carbonizer known as Hi-Carbon Compound; B-G Compound for hardening, serving the same purpose as cyanide without giving off deadly fumes; Enamelite, which when applied to low carbon steel will prevent the steel from absorbing carbon during the casehardening process, producing soft areas where they are desirable; Bath-ite, a compound used for preheating between 1,200 and 1,600 deg. F., making it possible to heat the work to a uniform temperature away from the air in order to eliminate scale and oxidization; and Cleancoat, for scouring the steel heated in lead baths.

Furnaces for Heat Treating.—Catalogue No. 75, containing 80 pages, 8½ in. by 11 in., has been published by the Chicago Flexible Shaft Company, Chicago, and is devoted to the Stewart gas and oil furnaces, which are adapted to a wide range of heat treating operations. These furnaces burn only gas or oil and are built in many designs and sizes to meet a great variety of conditions, the line being divided into oven, crucible and forge types. Several special features of the Stewart furnaces are described, including a U-shaped bottom slab which makes it unnecessary to use muffles and gives to the furnace area the advantage of the transfer of heat through the bottom and sides of the enclosure. The many types of furnaces are separately described and illustrated, specifications and prices being given also, in addition to which the book contains instructions as to the proper methods of hardening steel, carbonizing, cyanide treating, etc.

Celfor Drills.—Putting Mettle Into Metal is the title given by the Clark Equipment Company, Buchanan, Mich., to a booklet describing the making of Celfor drills and precision tools, and telling of various innovations which the company has put into effect for the benefit of employees, which tend to give them a keener interest in their work and promote harmony between employer and employees. The booklet contains numerous illustrations, one colored two-page illustration showing a general view of the plant and grounds which have been made into an attractive park. Other illustrations show a theatre which is operated by the company without profit and is used by the employees for a great variety of activities; a hospital which is conducted by a hospital association formed among employees, and several homes which are typical of a large number built by the company and sold to employees at actual cost.